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&c.

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PALÆONTOLOGICAL MEMOIRS AND NOTES

OF THE LATE

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VICE-PRESIDENT OF THE ROYAL SOCIETY;

FOREIGN SECRETARY OF THE GEOLOGICAL SOCIETY OF LONDON;

AND FOR MANY YEARS

SUPERINTENDENT OF THE H. E. I. COMPANY'S BOTANICAL GARDENS

AT SUHARUNPOOR AND CALCUTTA.

WITH A

Biographical Sketch of the Author.

COMPILED AND EDITED BY

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FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS OF LONDON.

VOL. II.

MASTODON, ELEPHANT, RHINOCEROS,

OSSIFEROUS CAVES,

PRIMEVAL MAN AND HIS COTEMPORARIES.

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1868.

This Volume is Dedicated to

M. ED. LARTET,

FOREIGN MEMBER OF THE GEOLOGICAL SOCIETY OF LONDON,

GEORGE BUSK, F.R.S.,

THE REV. JOHN GUNN, F.G.S.,

JOSEPH PRESTWICH, F.R.S.,

CAPT. SPRATT, R.N., C.B.,

AND

COLONEL WOOD, F.G.S.,

THE FREQUENT MENTION OF WHOSE NAMES IN ITS PAGES

TESTIFIES TO THEIR HAVING BEEN

ALIKE THE FRIENDS AND FELLOW-LABOURERS

OF

ITS AUTHOR.

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Page 52 line 17 of Note 3. *For* ereur, *read* erreur.

„ 92 „ 27. *For* mandibule, *read* mandible.

„ 135 „ 4 & 38. *For* channeled, *read* channelled, and *for* channeling, *read* channelling.

„ 137 „ 37. *For* channeled, *read* channelled.

„ 138 „ 32. *For* channeling, *read* channelling.

„ 147 *In notes* 1 *and* 2 *for* Plate VIII. *substitute* Plate VI.

„ 188, line 6. *For* Amasses? *read* Anapus.

„ 188 „ 21. *For* Folger's, *read* Foulger's.

„ 199 „ 15. *For* lagon, *read* lagoon.

„ 207 „ 14. *For* Liberensis, *read* Liberiensis.

„ 208 „ 40. *For* Sutton, *read* Stutton.

„ 270 „ 36. *For* continuous, *read* contiguous.

„ 309, last line. *For* tichorinus, *read* tichorhinus.

„ 310, lines 28 & 38. *For* tichorinus, *read* tichorhinus.

„ 311 „ 3, 10, & 18. *For* tichorinus, *read* tichorhinus.

„ 325 „ 11. *For* left, *substitute* right.

„ 330 „ 3 from bottom. *For* fig. 5, *read* fig. 3.

„ 351 „ 12 of second paragraph. *For* B. M. 132,133, *read* B. M. 27,836.

„ 353 „ 1. *For* Cesell's, *read* Ceselli's.

„ 355 „ 7. *For* Sub-Appenines, *read* Sub-Apennines.

„ 356 „ 17. *For* about, *read* orbital.

„ 359 „ 19. *For* ou, *read* o.

DESCRIPTION OF PLATE I.

Representations in outline of crania of Proboscidea: anterior views, drawn to scale, one-twentieth of the natural size. The figures in this Plate have been reproduced from the original drawings by Mr. Ford in Plates XLII. and XLIII. of the Fauna Antiqua Sivalensis (see vol. i. p. 476), in which the crania are drawn one-eighth of the natural size. (See page 14.)

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DESCRIPTION OF PLATE II.

Representations in outline of crania of Proboscidea: profile views, drawn to scale, one-twentieth of the natural size. The figures in this Plate have been reproduced from the original drawings by Mr. Ford in Plates XLIV. and XLV. of the Fauna Antiqua Sivalensis (see vol. i. p. 476), in which the crania are drawn one-eighth of the natural size. (See page 14.)

Fig. 1. *Dinotherium giganteum.* After Kaup.

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DESCRIPTION OF PLATE III.

MASTODON (TETRALOPHODON) LONGIROSTRIS AND MASTODON (TRILOPHODON) ANGUSTIDENS.

The figures in this Plate have been copied from those by Mr. Ford in Plate XI., vol. xiii., of the Quart. Journ. Geol. Soc., with which the memoir on Mastodon was originally illustrated. They are rather less than one-fourth (two-ninths) of the natural size.

Fig. 1. *Mastodon* (*Tetralophodon*) *longirostris*, Kaup, from Eppelsheim: plan-view of the penultimate true molar from the left side of the upper jaw. *a*, anterior talon; *t*, posterior talon; *b*, *c*, *d*, *e*, the four principal ridges which compose the crowns of the 'intermediate molars' in the Tetralophodons. An irregular longitudinal cleft along the middle divides the crown into an inner and outer division. (See page 24.)

Fig. 2. The same tooth seen in profile. From a cast in the Geological Society's collection.

Fig. 3. *Mastodon* (*Trilophodon*) *angustidens*, from the Dép. Gers, in the Sub-Pyrenees: plan-view of the penultimate true molar from the left side of the upper jaw, showing the worn discs of the three principal ridges which compose the crowns of the 'intermediate molars' in the Trilophodons. *a*, anterior talon; *t*, posterior talon; *b*, *c*, *d*, the three ridges. The longitudinal cleft is partially worn out. (See page 22.)

Fig. 4. The same tooth, seen in profile. From a specimen in the collection of M. Lartet, For. Mem. G. S., Seissan, Gers.

DESCRIPTION OF PLATE IV.

MASTODON (TETRALOPHODON) ARVERNENSIS FROM THE CRAG.

The figures in this Plate have been copied from those by Mr. Ford in Plate XII., vol. xiii., of the Quart. Journ. Geol. Soc., with which the memoir on Mastodon was originally illustrated. They are rather less than one-fourth (two-ninths) of the natural size.

[The letters to the figures refer to the same parts as in fig. 1, Pl. III.]

Fig. 1. *Mastodon* (*Tetralophodon*) *Arvernensis*, from Ramsey, near Harwich: plan-view of the germ of the penultimate true molar from the right side of the upper jaw. (See page 33.)

Fig. 2. The same tooth, seen in profile. A large flanking mammilla is seen to occupy the middle of each valley. This specimen is in the collection of the Rev. J. R. Marsden, Great Oakley, Essex.

Fig. 3. *Mastodon* (*Tetralophodon*) *Arvernensis*, from Suffolk: plan-view of the germ of the last true molar from the left side of the lower jaw. (See page 31.) *b*, *c*, *d*, *e*, *f*, the five ridges composing the crown, the mammillæ of which are disposed alternately.

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DESCRIPTION OF PLATE V.

Elephas (Stegodon) Cliftii and Elephas (Stegodon) insignis.

Figs. 1 and 2. *Elephas Cliftii.* Views in plan and profile of last true molar, lower jaw, left side, rather less than one-fourth (two-ninths) of the natural size. Copied from drawings by Mr. Ford in Plate XXX., figs. 5 and 5 *a*, of the Fauna Antiqua Sivalensis. (See page 85, and vol. i. p. 462.)

Figs. 3 and 4. *Elephas insignis.* Views in plan and profile of a fragment of lower jaw containing the last true molar, rather less than one-fourth (two-ninths) of the natural size. Copied from drawings by Mr. Ford in Plate XX., figs. 8 and 8 *a*, of the F. A. S. (See page 85, and vol. i. p. 452.)

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ELEPHAS (LOXODON) AFRICANUS, ELEPHAS (LOXODON) PLANIFRONS, ELEPHAS (EUELEPHAS) INDICUS, AND ELEPHAS (EUELEPHAS) PRIMIGENIUS.

Fig. 1. *Elephas Africanus.* First true molar, lower jaw, left side, one-half of the natural size. Reproduced from a drawing by Mr. Ford in Plate XIII. A, fig. 8, of the Fauna Antiqua Sivalensis. (See page 90, and vol. i. p. 440.)

Fig. 2. *Elephas planifrons.* Last true molar, lower jaw, left side, three-eighths of the natural size. Reproduced from a drawing by Mr. Ford in Plate XI., fig. 2, of F. A. S. (See page 92, and vol. i. p. 430.)

Fig. 3. *Elephas Indicus.* Last true molar, lower jaw, right side, of the existing Indian Elephant, three-eighths of the natural size. Reproduced from a drawing by Mr. Ford in Plate XIII. A, fig. 6, of the F. A. S. (See pages 147 & 151, and vol. i. p. 440.)

Fig. 4. *Elephas primigenius.* Last true molar, lower jaw, right side, three-eighths of the natural size. Copied from a drawing by Mr. Ford in Plate XIII. A, fig. 1, of the F. A. S. (See pages 147 & 159, and vol. i. p. 439.)

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Fig. 1. Crown view of last lower molar, left side, one-third of the natural size. The drawing is a copy of one by Mr. Ford in Plate XIV., fig. 7, of the Fauna Antiqua Sivalensis. The specimen is from Grays Thurrock, and is now in the British Museum. (Cat. No. 39,370.) It is fully described at page 96.

Fig. 2. Vertical longitudinal section of same tooth, one-half of the natural size. Copied from Plate XIV., fig. 7 *b*, of the F. A. S.

Figs. 3 and 4. Views in plan and profile of the penultimate true molar, lower jaw, left side, one-half of the natural size. These drawings have been executed by Mr. Dinkel from the original specimen in the collection of the Rev. John Gunn, which Mr. Gunn forwarded to London for the purpose, subsequently to Dr. Falconer's death. The specimen is fully described at page 99.

DESCRIPTION OF PLATE VIII.

ELEPHAS (LOXODON) MERIDIONALIS.

Fig. 1. Last true molar, lower jaw, right side, one-third of the natural size. The drawing is a copy of one by Mr. Ford in Plate XIV. B, fig. 18, of the Fauna Antiqua Sivalensis. The specimen from the 'Mammaliferous Crag' is in the Norwich Museum, and is fully described at page 130.

Figs. 2 and 3. Views in plan and profile of a lower molar from the Val d'Arno, in Dr. Buckland's collection, in the Oxford Museum. The drawings are one-third of the natural size, and are copies of those by Mr. Ford in the F. A. S., Plate XIV. B, figs. 17 and 17 *a*. (See page 131.)

Fig. 4. Crown of a last upper molar, left side, of a very old animal, in an advanced stage of wear. The specimen is in the Norwich Museum, and is described at page 137. The drawing, one-third of the natural size, is copied from one by Mr. Ford in the F. A. S., Plate XIV. B, fig. 14 *a*.

DESCRIPTION OF PLATE IX.

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Figs. 3 and 4. Views in plan and profile of last molar, lower jaw, left side, from Saffron Walden. A description of the specimen will be found at page 443 of vol. i. The drawings, one-third of the natural size, are copied from those by Mr. Ford in the F. A. S., Plate XIV. A, figs. 11 and 11 *a*. (See pages 147 & 184.)

Fig. 5. Another last lower molar, left side, from Rome, described at page 443 of vol. i. The drawing is one-third of the natural size, and is a copy of one by Mr. Ford in the F. A. S., Plate XIV. A, fig. 13 *a*. (See page 185.)

[Fig. 4 of Pl. XIII. A of F.A.S. has not been reproduced in this Plate as stated at p. 440 of vol i. See list of Errata in vol. i.]

DESCRIPTION OF PLATE X.

ELEPHAS (EUELEPHAS) COLUMBI AND ELEPHAS (EUELEPHAS) ARMENIACUS.

The figures in this Plate have been copied from drawings by Mr. Dinkel, which appeared in the 'Natural History Review' for 1863, Plates I. & II.

Fig. 1. *Elephas Columbi.* Section of the middle portion of an adult lower molar, from the Post-Pliocene deposit of the Brunswick Canal, near Darien, in Georgia, one-half of the natural size; showing the disposition and relative proportions of the ivory, enamel, and cement, as compared with corresponding sections of *E. Indicus* and *E. primigenius*, contained in the Fauna Antiqua Sivalensis, and in Plate V. of vol. i. (See page 222.)

Fig. 2. *Elephas Columbi.* Represents the crown aspect of an antepenultimate true molar, of the lower jaw, left side (m. 1), one-half of the natural size. No. 741 *a*, Mus. Coll. of Surg. The eight anterior ridges are worn, the rest being intact. From Mexico. (See page 220.)

Fig. 3. *Elephas Armeniacus.* Represents the crown aspect of the last true molar (m. 3), upper jaw, left side, of *E. Armeniacus*, from a specimen in the British Museum, No. 32,250, procured by Col. Giels, in the province of Erzeroum in Armenia. One-half of the natural size. (See page 247.)

DESCRIPTION OF PLATE XI.

ELEPHAS (LOXODON) MELITENSIS.

The figures in this Plate are of the natural size, and have been copied from drawings executed by Mr. Dinkel for Dr. Falconer, from the original specimens forwarded from Malta by Capt. Spratt.

Figs. 1 and 1 *a*. Views in plan and profile of last upper true molar, left side. Described at page 292.

Figs. 2 and 2 *a*. Views in plan and profile of penultimate upper true molar, right side. Described at page 294.

Figs. 3, 3 *a*, and 3 *b*. Three different views of a very perfect specimen of the milk tusk. Described at page 296.

Figs. 4 and 4 *a*. Views in plan and profile of a germ specimen of the penultimate upper milk molar, or m. m. 3. (See page 297.)

DESCRIPTION OF PLATE XII.

Elephas (Loxodon) Melitensis.

The figures in this Plate are of the natural size, and have been copied from drawings executed by Mr. Dinkel for Dr. Falconer, from the original specimens forwarded from Malta by Capt. Spratt.

Figs. 1 and 1 *a*. Views in plan and profile of antepenultimate milk molar, m. m. 2. (See page 297.)

Figs. 2 and 2 *a*. Views in plan and profile of penultimate lower milk molar, or m. m. 3. (See page 297.)

Figs. 3 and 3 *a*. Views in plan and profile of the last lower milk molar, or m. m. 4, showing the crown perfect. (See page 297.)

Figs. 4 and 4 *a*. Views in plan and profile of last lower true molar, or t. m. 3. (See page 298.)

DESCRIPTION OF PLATE XIII.

ELEPHAS (LOXODON) MELITENSIS.

The figures in this Plate are copied from drawings executed by Mr. Dinkel for Dr. Falconer, from the original specimens forwarded from Malta by Captain Spratt. Dr. Falconer has inscribed on the drawings 'Zebbug Cave, Malta. Captain Spratt, R.N.'

Figs. 1, 2, 3, and 4. Four different views of a dorsal vertebra, one-half of the natural size, apparently that described at page 302.

Figs. 5 and 6. Two different views of a fragment of the pelvis, showing the acetabulum, probably that referred to at page 303. One-third of the natural size.

DESCRIPTION OF PLATE XIV.

Elephas (Loxodon) Melitensis.

The figures in this Plate are one-third of the natural size, and have been copied from drawings executed by Mr. Dinkel for Dr. Falconer, from the original specimens forwarded from Malta by Captain Spratt.

Figs. 1, 2, 3, 4, and 5. Represent the anterior, outer, and posterior aspects of the shaft, the lower articular surface, and a transverse section of the left humerus, apparently that described at page 303.

Figs. 6, 7, 8, 9, and 10. Represent the posterior, inner, and anterior surfaces and section of the shaft of the left femur, apparently that described at page 303.

DESCRIPTION OF PLATE XV.

RHINOCEROS HEMITŒCHUS.

The figures in this Plate represent the 'Clacton Skull' in the British Museum (Cat. No. 27,836, not 132,133, as stated in text), described by Professor Owen, in the 'British Fossil Mammalia,' as *Rhinoceros leptorhinus*. The figures have been copied from original drawings executed for Dr. Falconer by Mr. Dinkel, and are one-ninth of the natural size. (See pages 317 & 351.)

Fig. 1. Profile view of cranium, showing partial nasal septum projecting downwards.

Fig. 2. Under surface. The posterior portion is only drawn in outline. At the anterior extremity is seen the nasal septum.

Fig. 3. Upper surface of cranium.

Fig. 4. Section of the nasal septum, one-third of the natural size.

DESCRIPTION OF PLATE XVI.

RHINOCEROS HEMITŒCHUS.

The figures in this Plate represent molars of *Rhinoceros hemitœchus* found in 'Minchin Hole,' Gower, formerly in the collection of Colonel Wood of Stout Hall, but now in the British Museum.[1] The figures are two-thirds of the natural size, and have been copied from drawings executed from the original specimens by Mr. Dinkel for Dr. Falconer. They are fully described at page 324, *et seq.*

Fig. 1. Shows the five last molars, *i.e.* the penultimate and last premolars, and the three true molars, of the upper jaw, right side. The antepenultimate premolar (p.m. 2) has been appended in outline from a reversed figure of the tooth on the opposite side of the same individual. The crochet (*a*) is well seen in the penultimate true molar. The specimen is fully described at page 324, *et seq.*

Fig. 2. Shows the four last molars of the upper jaw, right side, but considerably more worn than those shown in fig. 1. A description of these teeth will be found at pages 325 & 329. At page 325, 'left side' has been misprinted for 'right side.'

Fig. 3. Represents a detached penultimate molar of the left side, being the counterpart from the opposite side of the tooth (m. 2) represented in fig. 1. The characteristic thick massive crochet (*a*), forming an acute angle with the anterior margin of the posterior barrel, is well shown. A description of the tooth will be found at pages 325 & 329.

[1] As these pages are passing through the Press, Col. Wood has presented to the British Museum these and other specimens of Rhinoceros remains found in the Gower Caves, which are described or figured in this work.

DESCRIPTION OF PLATE XVII.

RHINOCEROS HEMITŒCHUS.

The figures in this Plate represent molars of *Rhinoceros hemitœchus* found in the Gower Caves by Colonel Wood. The figures are three-fourths of the natural size, and have been copied from drawings executed from the original specimens for Dr. Falconer by Mr. Dinkel.

Figs. 1 and 2. Show in plan and profile a fragment of the right side of the upper jaw, containing the last premolar mutilated at the outer surface, and the antepenultimate and penultimate true molars, the latter having the inner side of the posterior barrel fractured. The crowns are in a less advanced stage of wear than in the specimens represented in figs. 1 and 2 of Plate XVI. (See pages 325 & 332.)

Figs. 3, 4, and 5. Represent three different views of a detached germ of the last true molar, upper jaw, left side, which had not yet come into use, and which presents all the folds and depressions of the enamel-shell in a very perfect manner. Fig. 3, crown surface. Fig. 4, inner surface. Fig. 5, outer surface. *a*, anterior colline; *b*, longitudinal colline; *c*, the continuation of the longitudinal colline which is the homologue of the posterior transverse colline; *d*, the crochet; *e*, the anterior barrel; *f*, the anterior basal bourrelet; *g*, the posterior barrel; *h*, a small tubercle at the posterior inner angle; *i*, vertical groove of the anterior outer angle; *k*, intercolumnar tubercle. (See pages 325 & 335.)

DESCRIPTION OF PLATE XVIII.

Rhinoceros leptorhinus (R. megarhinus), Rhinoceros hemitœchus, and Rhinoceros bicornis.

Figs. 1 and 2. Represent the two varieties of the last upper premolar, right side, of *Rhinoceros leptorhinus* (*R. megarhinus*, Christ.), referred to at page 328 of the text, in one of which (fig. 1) there is a very pronounced basal bourrelet, while the other (fig. 2) is entirely free from it. These two figures have been copied from the illustrations of De Christol's memoir in the Ann. des Sc. Nat. 2me. Sér. tom. vi. Zool. Pl. III., figs. 10 and 4. In both, the 'combing plate' (R) is seen converging diagonally to meet the plane of the crochet (T) nearly at a right angle. The drawings are about two-thirds of the natural size.

Fig. 3. Represents the penultimate true molar, upper jaw, right side, of *Rhinoceros leptorhinus* (*R. megarhinus*, Christ.), two-thirds of the natural size. The section of the crochet is wedge-shaped, thinning from a broad base to a sharp edge, and it forms a very open angle with the disc of the posterior colline. This specimen is referred to at page 331, and the figure has been copied from Plate III., fig. 3 (not fig. 5, as stated in text), of De Christol's memoir above referred to.

Fig. 4. Penultimate upper molar, left side, of *R. leptorhinus* (*R. megarhinus*), yielding precisely the same characters as fig. 3. It is about two-thirds of the natural size and has been copied from the 'Paléontologie Française,' by Gervais, Pl. II., fig. 5. It is referred to at page 331.

Fig. 5. Last upper molar of *Rhinoceros hemitœchus*, two-thirds of the natural size, showing an abnormal condition of the crochet. The specimen is believed to have been procured from Grays Thurrock, and is now in the Museum of the College of Surgeons. Dr. Falconer's reasons for regarding this tooth as belonging to *R. hemitœchus*, rather than to *R. leptorhinus*, will be found at page 337.

Figs. 6 and 7. Two views of a germ of last upper molar, left side, of the existing species, *Rhinoceros bicornis*, two-thirds of the natural size. Fig. 6, inner side. Fig. 7, crown. *a*, anterior colline; *b*, longitudinal colline; *c*, continuation of longitudinal colline, which is the homologue of the posterior transverse colline; *d*, the crochet; *e*, anterior barrel; *f*, anterior basal bourrelet; *g*, posterior barrel; *h*, small tubercle at posterior inner angle; *i*, the vertical groove of the anterior outer angle. (See page 335.) The specimen is now in the British Museum.

DESCRIPTION OF PLATE XIX.

Rhinoceros hemitœchus.

Figs. 1 and 2. Represent in plan and profile the greater portion of the horizontal ramus of the lower jaw, left side, containing the full series of six molars usually seen in the adult, in the stage ot wear best suited to show all the characters. The specimen was found in Minchin Hole by Colonel Wood. The figures are one-half of the natural size, and have been copied from drawings of the original specimens executed for Dr. Falconer by Mr. Dinkel. (See page 340, *et seq.*)

DESCRIPTION OF PLATE XX.

Rhinoceros hemitœchus.

Figs. 1 and 2. •Represent in plan and profile the greater portion of the horizontal ramus of the lower jaw, left side, showing the five last molars *in situ*, and the empty alveolus of the antepenultimate premolar. The teeth are much further advanced in wear than in the specimen shown in Plate XIX. The specimen was found in 'Minchin Hole' by Colonel Wood, and the figures, one-half of the natural size, have been copied from drawings executed for Dr. Falconer by Mr. Dinkel. (See page 340, *et seq.*)

DESCRIPTION OF PLATE XXI.

Rhinoceros hemitœchus.

Fig. 1. Represents a mutilated right ramus of the lower jaw, exhibiting the six posterior molars *in situ*, together with a portion of the symphysial expansion. The specimen is remarkable in showing the abnormal condition of two collateral teeth for the last premolar. The crowns are seen in the early stage of abrasion of the adult animal. The specimen was discovered in 'Bacon Hole,' and was presented to the Swansea Museum by Colonel Wood. The figure is about one-half of the natural size and has been copied from a drawing belonging to Mr. Spence Bate. (See pages 340 & 349.)

Figs. 2 and 3. Represent two views in profile and plan, of a fragment of the right upper maxilla with the milk dentition. The first, second, and third milk molars are *in situ*, and part of the alveolus of the fourth milk tooth is also seen. The specimen is among Colonel Wood's collections from the Gower caves, and is believed to have been found in 'Minchin Hole.' The figures are about two-thirds of the natural size, and have been copied from drawings executed for Dr. Falconer by Mr. Dinkel. (See page 353.) Dr. Falconer was struck with the resemblance which this specimen presents to a cast of the dentition of *Rhinoceros Lunellensis*, sent to him by M. Gervais, and now deposited in the British Museum. (See page 309.)

DESCRIPTION OF PLATE XXII.

Rhinoceros Etruscus.

Figs. 1 and 2. Represent in profile and plan the greater part of the horizontal ramus of the left side of the lower jaw, with the three true molars *in situ*, and the empty alveoli of the three last premolars. *The specimen is in the collection of the Rev. John* Gunn, of Irstead, and was found in the Forest-bed of the Norfolk Coast. The drawings are about two-fifths ($\frac{9}{23}$) of the natural size (the length of crowns of three teeth at inner edges being 5·1 inches), and have been executed by Mr. Dinkel from the original specimen which was forwarded to London for the purpose by Mr. Gunn. (See page 345.)

Fig. 3. Represents a specimen also from the Forest-bed of the Norfolk Coast, formerly in the collection of the Rev. James Layton, and now in the British Museum (Cat. No. 33,326). It is a fragment of the left ramus of the lower jaw, containing the last premolar, the first two true molars, and the anterior fang of the last molar. The drawing is about two-fifths of the natural size, and has been executed by Mr. Dinkel from the original specimen. (See page 345.)

Fig. 4. Is a fragment in the British Museum (Cat. No. 28,802), from the Val d'Arno; showing the alveolar portion of the left ramus of the lower jaw, containing the last premolar and the three true molars *in situ*. The drawing is about one-third of the natural size, and has been executed by Mr. Dinkel from the original specimen.

Fig. 5. Represents the first true molar, upper jaw, left side. The figure is three-fourths of the natural size, and has been copied from a drawing made for Dr. Falconer, and on which he had written: '*Rhinoceros Etruscus*—t. m. 1. l. Happisburgh. The Rev. J. Gunn. Coll. Yarmouth Museum.'

DESCRIPTION OF PLATE XXIII.

Rhinoceros hemitœchus.

Figs. 1 and 2. Represent the basal view of two crania, the one found in 'Minchin Hole,' the other from Northampton, showing their similarity. The figures are one-fourth of the natural size. (See pages 351 & 509.)

Fig. 1. Represents the basal view of a portion of cranium found in 'Minchin Hole,' taken from a drawing executed for Dr. Falconer by Mr. Dinkel.

Fig. 2. Represents the basal view of the 'Northampton Skull' in the British Museum (Cat. No. 20,013), also taken from a drawing executed for Dr. Falconer by Mr. Dinkel.

DESCRIPTION OF PLATE XXIV.

Rhinoceros hemitœchus.

The figures in this Plate have been reproduced from drawings by Mr. Dinkel of the original specimens. (See pages 351 & 509.)

Fig. 1. Is a lateral view of the 'Northampton Skull' in the British Museum (Cat. No. 20,013), right side.

Fig. 2. Is a lateral view of skull found in 'Minchin Hole,' left side.

Fig. 3. Is a view of upper surface of skull found in 'Minchin Hole.'

DESCRIPTION OF PLATE XXV.

RHINOCEROS HEMITŒCHUS AND RHINOCEROS ETRUSCUS.

Fig. 1. Outer surface of left ramus of young lower jaw of *R. hemitœchus*, with greater part of symphysis and whole of horizontal ramus, and containing the first four milk molars. The figure is one-half of the natural size, and has been copied from a drawing of the original specimen executed for Dr. Falconer by Mr. Dinkel. The specimen is from 'Minchin Hole,' and is described at page 352.

Figs. 2, 3, and 4. Represent upper milk molars of *R. hemitœchus*, from 'Minchin Hole,' of the natural size, copied from drawings of the original specimens executed for Dr. Falconer by Mr. Dinkel. (See page 352.) Fig. 2 shows the second and third milk molars. Fig. 3 is a germ of the second milk molar. Fig. 4 is a detached third milk molar.

Figs. 5, 6, and 7. Represent three upper molars of *R. Etruscus*. The drawings have been made by Mr. Dinkel from three casts presented to Dr. Falconer by Professor Meneghini, of Pisa, and now in the British Museum. They are of the natural size. Fig. 5 shows the crown of the last (t. m. 3) upper molar of the left side. Fig. 6 is the last upper premolar (p. m. 4), right side. Fig. 7 is the penultimate upper molar (t. m. 2), right side, mutilated at posterior outer angle.

DESCRIPTION OF PLATE XXVI.

Rhinoceros Etruscus.

Three different views of cranium in the Florence Museum, one-fifth of the natural size. Fig. 1. Upper surface. Fig 2. Profile view, showing well the incomplete nasal septum. Fig. 3. Lower surface, showing palate and series of six molars on either side well worn. These figures have been copied by Mr. Dinkel from drawings executed for Dr. Falconer by Vincenzo Stanghi, artist at Florence. (See page 356.)

DESCRIPTION OF PLATE XXVII.

RHINOCEROS ETRUSCUS.

Views of cranium, lower jaw, and teeth in the Florence Museum. The figures have been copied by Mr. Dinkel from drawings executed for Dr. Falconer by Vincenzo Stanghi, artist at Florence. (See page 356.)

Fig. 1. Posterior view of cranium represented in Plate XXVI., showing occiput, zygomatic arches, occipital condyles, and foramen magnum, one-fourth of the natural size.

Fig. 2. Profile view of lower jaw, outer surface, one-fourth of the natural size.

Fig. 3. Same lower jaw, viewed from above, showing crowns of molars far advanced in wear, one-fourth of the natural size.

Fig. 4. Symphysial portion of same lower jaw, viewed from below, one-fourth of the natural size.

Fig. 5. Four molars of upper jaw, left side, smaller and less advanced in wear than those in skull represented in Plate XXVI., fig. 3. Three-fourths of the natural size. (The dimensions almost correspond to those given in page 359.)

DESCRIPTION OF PLATE XXVIII.

Rhinoceros Etruscus.

Fig. 1. Is a profile view of a cast of a skull of the Val d'Arno Rhinoceros in the Museum at Pisa, showing the septum distinctly limited to the anterior half of the nasal bones and terminating in a thickened portion united to the incisive bone. The figure is one-fourth of the natural size, and has been copied from a drawing executed for Dr. Falconer by Pierucci, artist at Pisa. (See page 359.)

Figs. 3, 4, and 5. Symphysial portion of the lower jaw, with part of the two rami belonging to the Marchese Carlo Strozzi, and described at page 360. The figures are one-half of the natural size, and have been reproduced from drawings by Mr. Dinkel. Fig. 2. Upper surface. Fig. 3. Under surface. Fig. 4. Lateral view.

DESCRIPTION OF PLATE XXIX.

Rhinoceros Etruscus.

This Plate represents the palate view of the cranium in the University Museum of Natural History at Bologna, described at page 363. The drawing is one-half of the natural size, and has been copied from one which Dr. Falconer had executed at Bologna, and on which he had inscribed '*Rhinoceros Etruscus*, Museum, Bologna.' A cast of the specimen which Dr. Falconer also brought from Bologna has been deposited in the British Museum.

DESCRIPTION OF PLATE XXX.

RHINOCEROS LEPTORHINUS (R. MEGARHINUS).

Three different views of lower jaw, one-fourth of the natural size. Fig. 1. Inner surface. Fig. 2. Shows crowns of molars and symphysial spout. Fig. 3. Outer surface. These drawings have been executed by Mr. Dinkel from a cast brought by Dr. Falconer from Montpellier, labelled 'Rhinoceros des Sables de Montpellier,' and now deposited in the British Museum. (See page 368.)

DESCRIPTION OF PLATE XXXI.

RHINOCEROS LEPTORHINUS (R. MEGARHINUS).

Fig. 1. Series of six molars of upper jaw, right side, described at page 395. The figure is one-half of the natural size, and has been reproduced from a drawing found in Dr. Falconer's collection, and on which he had inscribed, '*Rhinoceros leptorhinus*, *R. megarhinus*, Christol, from specimen in Municipal Museum of Imola. Scarabelli.'

Fig. 2. Series of six molars of upper jaw, left side, one-half of the natural size, copied from a lithograph found in Dr. Falconer's collection, and on which he had written: 'Unpublished lithograph of skull of fossil Rhinoceros belonging to the Lyons Museum, for a work by Professor Jourdan of Lyons. *Rhinoceros leptorhinus*, Cuv., *pro parte*, *R. megarhinus*, Christol.' The artist has improved on the original drawing by the assistance of a cast of the same skull presented to Dr. Falconer by Professor Jourdan, and which is now deposited in the British Museum. (See page 369.)

Fig. 3. Represents the cranium of *R. leptorhinus*, referred to under fig. 2, one-seventh of the natural size. The drawing has been executed from the same materials as fig. 2. As in the case of the Cortesi cranium, the specimen is somewhat distorted from crushing. (See pages 369 & 381.)

h. Impression of the three premolars on the matrix.
i. Empty sockets of the two true molars.
n. Orifice of dentary canal.
o. Indication of the raised and inflected fold of the posterior inner margin.

Fig. 5. *k.* Third or largest premolar, showing the seven diagonal grooves; magnified 5½ diameters.

Fig. 6. *l.* Corresponding premolar in the recent Australian *Hypsiprymnus Gaimardi*, showing the seven vertical grooves; magnified 3½ diameters.

Figs. 7, 8, 9, and 10. *Plagiaulax Becklesii.* Portion of the right ramus of a lower jaw, and different views of the two true molars.

Fig. 7. A portion of the jaw, with two molars *in situ*, magnified 10 diameters; fig. 8, inner side of the molars, magnified 10 diameters; fig. 9, outer side, 7 diameters; fig. 10, summits of the crowns of the molars, 7 diameters.

Fig. 7. *a.* Anterior margin of the coronoid process.
b. Fractured posterior margin.
pm. Impression of the last premolar.
m. 1. First true molar.
m. 2. Second true molar.

Figs. 8, 9, and 10. *a.* Anterior inner point of penultimate molar.
b. Posterior inner point of the same molar, showing the disc of wear.
c. Anterior outer point.
d. Posterior outer edge.
ee. Fractured surface of interior edge of the last molar.
ff. Ground surface of outer edge of the same.

Figs. 11, 12, and 13. *Plagiaulax Becklesii.* Fragments consisting of the anterior portion of the right ramus of the lower jaw, magnified 2 diameters; fig. 11, outer surface; fig. 12, inner surface; fig. 13, vertical view seen from above; *a*, incisor; *pm*, premolars; *b*, symphysial harmonia; *c*, mentary foramen.

DESCRIPTION OF PLATE XXXIV.

PLAGIAULAX BECKLESII. P. MINOR. MICROLESTES ANTIQUUS. THYLACOLEO CARNIFEX. CHEIROMYS MADAGASCARIENSIS.

The drawings in this Plate have been reproduced from the woodcuts which accompanied the memoirs as originally published in the Quart. Journ. Geol. Soc. for August, 1857, and November, 1862. (See pages 412 & 436.)

Fig. 1. *Plagiaulax Becklesii.* The left ramus of the lower jaw, nearly perfect, showing the outer surface. Magnified 4 diameters. *a*, incisor; *b*, condyle; *c*, coronoid process, broken at the edges; *d*, inferior boundary ridge; a depression is seen on the inner surface of the bone at the base of the coronoid; *pm.*, premolars.

Figs. 2 to 6. *Plagiaulax minor.*

Fig. 2. Outside of the right ramus of the lower jaw, magnified 4 diameters. All the teeth are in place and well preserved. The hinder part of the jaw-bone, with the ascending ramus and posterior angle, is broken away.

a. Incisor with point broken off. *a′*, impression of same, showing that the inner side near the apex was hollowed out in a longitudinal direction.

b. Offset of coronoid, the rest of which is wanting.

m. The two true molars.

pm. The four premolars.

e. The length of the jaw, natural size.

Figs. 3 and 4. The first molar, magnified 8 diameters; 3, the crown; 4, side-view.

Figs. 5 and 6. Second molar; the crown and side-view.

Figs. 7 and 8. Teeth of *Microlestes antiquus* of Plieninger, from the Upper Trias of Wirtemberg. Magnified.

Fig. 7. Crown of the smaller molar.[1]

Fig. 8. Crown of larger tooth,[2] with part of the crown broken off.

[1] See Lyell's Manual Elem. of Geol. 5th edit., fig. 441 *b*, p. 343.
[2] Ibid. fig. 442.

Figs. 9, 10, 11, and 12. Posterior half of a carnassial tooth (pm. 4) from the left side of the lower jaw of *Thylacoleo carnifex*. Preserved in the Museum of the Royal College of Surgeons.

Fig. 9. Inner side. *a*, hinder end, showing the undulations of the enamel-surface on the base of the crown, and the rugosely reticulate surface below the summit. Drawn for comparison with figs. 5 and 6 of Plate XXXIII., showing the same teeth in *Plagiaulax* and *Hypsiprymnus*.

Fig. 10. Outer side. *a*, hinder end.

Fig. 11. Top aspect, showing the undulations. *a*, hinder end.

Fig. 12. Section, showing the broken edge of the middle of the crown.

Figs. 13 and 14. The right ramus of the lower jaw of the Aye-Aye (*Cheiromys Madagascariensis*); the outer aspect. Natural size.

a. Incisor.

b. Molar teeth.

c. Coronoid process.

d. Condyle, having its articular surface below the grinding-plane of molars.

e. Angle of jaw. (The letter *e* has been omitted by the engraver, but ought to have been placed at posterior angle of lower margin, where this turns up into neck of condyle.)

f. Conjectural dotted line.

Fig. 14. End-view of condyle.

DESCRIPTION OF PLATE XXXV.

SPERMOPHILUS. FELIS SPELÆA.

Figs. 1, 2, 3. Three different views of lower jaw, right side, of *Spermophilus erythrogenoides*, from the Mendip Hills, of the natural size. Fig. 1, shows crowns of molars; fig. 2, outer surface of jaw; fig. 3, inner surface. The figures have been reproduced from drawings executed for Dr. Falconer by Mr. Dinkel, and described at page 452, where the words 'inner' and 'outer,' as referring to figures 2 and 3 respectively, ought to be reversed.

Figs. 4 to 9. Represent lower jaws of existing species of *Spermophilus*, drawn for Dr. Falconer by Mr. Dinkel, from specimens in the Osteological Collection of the British Museum. Of the natural size.

Figs. 4 and 5. *Spermophilus concolor.*

Figs. 6 and 7. *S. Eversmanii.*

Figs. 8 and 9. *S. erythrogenys.*

Fig. 10. Right side of lower jaw of fossil Spermophilus, from Salisbury. Outer surface; natural size. (See page 453.)

Fig. 11. Right carnassier of *Felis spelæa* from the Mendip caverns. Copied from a rough pencil sketch in one of Dr. Falconer's Note-Books. (See page 455.)

DESCRIPTION OF PLATE XXXVI.

CANIS AND URSUS.

The figures in this Plate have been drawn by Mr. Dinkel from the original specimens, formerly in the collection of Colonel Wood, of Stout Hall, but now deposited in the British Museum.

Fig. 1. Upper margin, showing teeth of lower jaw of the Hyænoid Wolf from Spritsail-Tor Cave, described at page 462. Three-fourths of the natural size.

Fig. 2. Outer surface of same specimen.

Fig. 3. Lower jaw of Ursus from 'Deborah's Den,' described at page 467; one-half of the natural size. Upper margin, showing the canine and penultimate molar, and behind the latter the opening which was drilled in search of the last tooth.

Fig. 4. Inner surface of same specimen.

Figs. 5 and 6. Represent the outer and inner surface of the left canine of Felis from N. Hill Tor Cave, referred to at page 458. Three-fourths of the natural size.

DESCRIPTION OF PLATE XXXVII.

CERVUS (EUCLADOCEROS) SEDGWICKII.

Fig. 1. Fossil Antler found at Bacton, and now in the collection of the Rev. John Gunn, of Irstead, described at page 472. The figure is between one-seventh and one-eighth of the natural size, and has been drawn by Mr. Dinkel from sketches furnished to Dr. Falconer by Mr. Gunn. The letters refer to the description in the text: *a*, bur; *a c*, pedicle; *a b*, beam; *d e*, supra-basilar; *h i*, median; *l m*, royal; *x y*, terminal portion of beam.

Figs. 2 and 3. Represent in outline the two basal fragments of shed horns presented to the Norwich Museum by the Rev. Mr. Foulger, and referred to by Dr. Falconer at page 475. The figures have been copied from rough outline sketches found among Dr. Falconer's papers, and are one-fourth of the natural size.

DESCRIPTION OF PLATE XXXVIII.

CROCODILUS CATAPHRACTUS AND CROCODILUS MARGINATUS.

The figures in this Plate have been reproduced from those which appeared originally in the Ann. and Mag. of Nat. Hist. for December, 1846.

Figs. 1, 2, and 3. Represent the cranium of *Crocodilus cataphractus* in the Belfast Museum, rather more than one-fifth of the natural size. Fig. 1, upper surface; fig. 2, palate surface; fig. 3, side view.

Figs. 4, 5, and 6. Represent the cranium of *Crocodilus marginatus* in the Belfast Museum, rather less than one-fifth of the natural size. Fig. 4, upper surface; fig. 2, palate surface; fig. 6, side-view.

I. ON THE SPECIES OF MASTODON AND ELEPHANT OCCURRING IN THE FOSSIL STATE IN GREAT BRITAIN.

BY H. FALCONER, M.D.

PART I. MASTODON.[1]

INTRODUCTION:—GENERIC DISTINCTIONS AND NOMENCLATURE OF THE PROBOSCIDEA—DINOTHERIUM—MASTODON AND ELEPHAS:—THE DISTINCTIVE AND SPECIFIC CHARACTERS OF MASTODON AND ELEPHAS:—THE BRITISH FOSSIL MASTODON, AND ITS COMPARISON WITH M. ANGUSTIDENS, M. ARVERNENSIS, AND M. LONGIROSTRIS—M. ANGUSTIDENS—M. ARVERNENSIS AND M. LONGIROSTRIS:—BRITISH SPECIMENS OF MASTODON—MOLARS—PREMOLARS—MILK MOLARS—LOWER JAW:—GEOLOGICAL AGE OF THE MASTODONS—MASTODON ANGUSTIDENS, M. LONGIROSTRIS, AND M. ARVERNENSIS—MASTODON OF THE CRAG IN PARTICULAR:—CONCLUSION.

Introduction.—It is of the highest importance to Geology, that every mammal found in the fossil state should be defined as regards, 1st, its specific distinctness, and, 2ndly, its range of existence geographically and in time, with as much exactitude as the available materials and the state of our knowledge at the time will admit. Every form well ascertained becomes a powerful exponent; while, ill-determined, it is a fertile source of error. For the pure Geologist, in most of his conclusions where age or climatal conditions are in question, is more or less at the mercy of the Palæontologist, since he must accept the palæontological evidence as it is laid before him, and square his speculations to fit and dovetail into the various mortises which the data inexorably present to him. There is a subordination in the value of the evidence: the higher the form in the scale of organization, the more weighty is the import of its indications.

[1] This paper was communicated to the Geological Society of London on April 8, 1857, and was published in the 'Quarterly Journal of the Geological Society' for November 1857, from which it is here reprinted with additions. The illustrations in Plates III. and IV. have been reproduced from those which accompanied the original memoir. The outline heads in Plates I. and II. have been copied from Plates XLII. to XLV. of the 'Fauna Antiqua Sivalensis.'—[ED.]

The difficulty with which the Mammalian palæontologist has to contend in arriving at satisfactory results depends doubtless, in many cases, on the imperfect nature and scantiness of his materials. But it is deserving of remark, that the fossil genera and species which are in the most unsatisfactory and unsettled state, as to definition and nomenclature, are not those that are the rarest, but often the reverse. Take *Mastodon* or *Rhinoceros*, for example, in which the array and confusion of specific names are signally perplexing. The reason of this apparent anomaly would seem to be this: when the remains are few and seldom met with, the species are usually limited in number, and thus more easily discriminated; on the other hand, when the remains are very abundant over wide areas, the species are at the same time, as a general rule, numerous: and it is well known among naturalists, that the genera which are the most difficult to disentangle specifically are the most complete and natural, where the species are many, and follow each other with the least amount of difference in serial development; or, in other words, where they are most closely allied to one another.

Remains of either of the Proboscidean genera, *Dinotherium*, *Mastodon*, and *Elephas*, abound in all the Tertiary Formations of Europe, Asia, and America, from the Miocene up to the Post-Pliocene; they have been the subject of a vast amount of observation, while it is hardly possible to conceive anything more unsettled and opposed than the generally received opinions respecting the species and their nomenclature in the standard works which are of the greatest authority on the subject. Cuvier, De Blainville, and Owen are agreed in limiting the Elephants and narrow-toothed Mastodons found fossil in Europe each to a single species; while other palæontologists consider that the latter group comprises at least three well-marked specific forms, and the former three or four. This palæontological uncertainty has naturally been reflected in systematic works on Geology, wherever the faunas of the Tertiary Formation are referred to, in statements sufficiently startling, which are repeated at the present day. Thus the Miocene *Mastodon angustidens*, of the Faluns of Touraine, of the Molasse of Switzerland and of the Sub-Pyrenees, as also the Miocene *Mastodon longirostris* of Eppelsheim, are mentioned by Sir Charles Lyell, in the fifth edition of his Manual,[1] under the comprehensive name (on the authority of Owen) of *Mastodon angustidens*, as occurring in the so-called 'Older Pliocene' Red Crag, and

[1] *Op. cit.* p. 156.

in the 'Pleistocene' Norwich Crag; while this English species of Mastodon, wherever it has been met with, whether in this country or on the Continent, has been almost invariably found in company with remains of a species of Elephant which Professor Owen has described as identical with the *Elephas primigenius* or Mammoth of the Post-Pliocene Drift and the modern Siberian ice-fields.

The object of the present communication is, to endeavour to ascertain what are the species of Mastodon and Elephant found fossil in Britain; what the specific names which ought to be applied to them; and what the principal formations and localities where they are elsewhere met with in Europe. I am the more induced to attempt the task from the circumstance that Prof. Owen, in an important memoir 'On some Mammalian Fossils from the Red Crag of Suffolk,' which appeared in a late number of the Society's Quarterly Journal,[1] adheres to the opinion expressed in his Report to the British Association for 1843, and subsequently discussed at greater length in his 'British Fossil Mammalia' in 1846, that the Mastodon of the English Crag is identical with the *Mastodon angustidens* of Cuvier, the *Mastodon longirostris* of Kaup, and the *Mastodon Arvernensis* of Croizet and Jobert. Prof. Owen, on both the occasions here quoted, up to 1846, has maintained the prevalent opinion, that all the Elephant remains met with in England are referable to a single species, namely *Elephas primigenius*; and I am not aware that he has altered his views upon this point in any subsequent publication. I have devoted much study to the subject, during the last fifteen years, in connexion with the numerous fossil species of both genera which are met with in India, with a view to a monograph of the Proboscidean family, fossil and recent. The results to which I have been conducted, as to the disputed European species, are different from those arrived at by Prof. Owen. The most of those results have been long exhibited, so far as figured evidence goes, in the published illustrations of the 'Fauna Antiqua Sivalensis';[2] but, having devoted the last summer and autumn to a Proboscidean examination, so to speak, of some of the principal collections on the Continent, with special reference to the European fossil species, I have been enabled to confirm or correct previous conclusions on a wider field of observation. In order to avoid needless repetition in the sequel, I may mention that the tour here referred to embraced a detailed study of the very extensive collection of

[1] No. 47, vol. xii. part iii. (Aug. 1, 1856), p. 223.

[2] Fauna Antiq. Sival. Illustr. part v. Plates xlii.—xlv. 1847. (Reproduced in Plates i. and ii. of this volume. See also vol. i. p. 476.—Ed.)

Val d'Arno Proboscidean remains contained in the Museum at Florence; the collections of Turin, Milan, and Pavia; of Geneva, Lausanne, Berne, Zurich, Basle, and Winterthur in Switzerland; of Darmstadt, Mannheim, and Strasbourg on the Rhine; of the Jardin des Plantes and École des Mines in Paris; the Duc de Luynes's fine collection of the Chartres Fossil Elephant, in Château Dampierre; and the surpassingly rich and unrivalled collection made by my friend M. Lartet, of the Sub-Pyrenean Proboscidea, at Seissan on the Garonne; together with some of the principal collections at Toulouse. In one or other of these Museums I had opportunities of studying all the fossil species hitherto described as having been met with in Europe, together with one fine species of Mastodon discovered by M. Lartet, but which has not yet been published.

Generic distinctions and nomenclature of the Proboscidea.—Before entering on the special consideration of the British fossil forms, it will be necessary to give some explanation of the principles on which the genera have been limited, and subdivided into subgeneric groups, in order to comprehend the reasons for the nomenclature adopted in this communication. A detailed palæontological disquisition would be out of place on the present occasion. Such salient points only will be touched upon as are essential to the elucidation of the subject.

The Proboscidean species, fossil and recent, constitute a large group, embracing at least twenty-five distinct forms, which are comprised under the three genera of *Dinotherium*, *Mastodon*, and *Elephas*. These genera, regarded in a systematic view, are of very unequal value numerically; the first being very limited in the number of ascertained species, but defined by well-marked generic distinctions; while the last two represent a large number of specific forms, which, although their opposite extremes are widely separated, yet are connected together through so complete and natural a series of intermediate specific links, that it has proved difficult to devise good generic characters to distinguish them. Putting aside all other considerations of structure and form, the diagnostic marks will be regarded on the present occasion solely as they are furnished by the teeth and jaws.

Dinotherium.—The adult dentition of *Dinotherium*[1] is characterized by two vertically succeeding premolars and three true molars, five teeth in all, with transverse crenulated ridges closely resembling those of the Tapir; and by two

[1] Kaup, Akten der Urwelt (1841), pp. 22–40.

huge inferior recurved incisors, implanted in an enormously thickened and deflected beak or prolongation of the symphysis of the lower jaw (Plate II. fig. 1). Most of the molar teeth present the normal Tapir-like crown character of two ridges; but, when the milk and permanent dentition are taken together, *Dinotherium* differs from all the non-elephantoid Pachydermata in the circumstance that the last milk molar and antepenultimate true molar (being contiguous teeth in the order of horizontal succession) present a more complex development of three ridges, or, a 'ternary-ridged crown formula' (to use a term which will be found of importance in the sequel). Two species only of *Dinotherium* have, I believe, hitherto been met with—the one in Europe, and the other in India.[1] The European species, *D. giganteum*, occurs in the Older Miocene formations, such as Eppelsheim, the Faluns of Touraine, and the Molasse and lacustrine strata of the Sub-Pyrenees; it has nowhere been met with in Britain.

Mastodon and Elephas.—Up to the date of the last 4to edition of the 'Ossemens Fossiles,' published during the author's life, in 1825, the species of *Mastodon* and *Elephas* then known were sufficiently well distinguished by the characters indicated by Cuvier,[2] the founder of the former genus; namely, that the molar teeth of *Mastodon* consisted of a comparatively simple crown, divided into mammillæ or tubercles, arranged in transverse ridges, more or less numerous, and more or less prominent, with corresponding empty valleys or hollows between them; while those of *Elephas* were more complex, consisting of numerous thin transverse plates, having their intervals filled up with cement. The subsequent

[1] As in the case of the Mastodon of North America, numerous nominal species have been founded by different authors (Kaup, Von Meyer, Eichwald, &c.) upon what would appear to have been merely varieties of the same species, depending on race, sex, &c., as evinced by the comparative size of the teeth. Dr. Kaup now entertains doubts of there being any other European species than *D. giganteum* (Akten der Urwelt, p. 49). The difference of size between the teeth of *D. giganteum* and *D. Cuvieri* is not greater than is known to occur between homologous teeth from different individuals of *Mastodon* (*Tetraloph.*) *longirostris*, dug out of the same deposit at Eppelsheim. The nominal species, *D. Kœnigii* of Kaup, is founded on a single small tooth, and therefore doubtful. I have lately seen well-marked specimens of fossil teeth of a species of Dinotherium from Attock in the Punjab, at no great distance from the Sewalik hills, and judging from the associated Mammalia, out of beds of the same age with them. The materials are not sufficient to establish whether the species is identical with *D. Indicum* of Perim Island, or distinct. In dimensions the teeth correspond with medium-sized specimens of *D. giganteum*. They were discovered by Lieut. Garnett, of the Bengal Engineers, and are now in the possession of Prof. Oldham, Superintendent of the Geological Survey of India, who has obligingly communicated them to me.—*July* 1857, H. F. (See vol. i. p. 414. A specimen of the third lower premolar of this species, from the 'Red Marl' at Noorpoor, found in Dr. Falconer's collection, is labelled in his hand-writing, '*Dinotherium Pentapotamicum*, Falc.'—Ed.)

[2] 'Oss. Fossiles,' tom. i. p. 205.

discovery of the *Mastodon Elephantoïdes* of Clift, in which Cuvier's characters of both genera are blended, and of European and American forms with tusks in the lower jaw (*Mastodon longirostris* and *Mastodon Ohioticus*), led to the necessity of remodelling the technical diagnostic characters of the genera. This was first attempted, so far as I am aware, by Bronn of Heidelberg, in his 'Lethæa Geognostica,' as far back as 1838. In his elaborate definition of the two genera, he states (omitting other characters) that Mastodon is characterized by lower incisors, and by molars which are replaced from back to front, excepting, however, the most anterior of these teeth, *i.e.* one or more milk molars; while in Elephant there are no inferior incisors, and *all* the molars are replaced in a horizontal direction.[1] In his remarks upon the species, he mentions that 'Tetracaulodon (i.e. *Mastodon longirostris*), according to Kaup, has premolars in the upper jaw, which are very similar to the back molars of Hippopotamus and are very caducous,'[2] and in regard to inferior tusks, that '*Mastodon giganteus*, *M. angustidens*, and *M. longirostris* do unquestionably possess such inferior tusks; the other species of Mastodon occur more rarely, and we can therefore only by analogy infer their having possessed them also.'[3] The same characters, *i.e.* of premolars and inferior incisors, were several years afterwards advanced by Prof. Owen (who must obviously have overlooked the previous remarks of Bronn) in his 'British Fossil Mammalia'[4] as being distinctive of Mastodon from Elephant in a well-marked and unequivocal manner. But they are assuredly neither absolute nor constant, whether regarded in a positive or negative view, as generic distinctions. For on the one hand, premolars have not yet been met with in *M.* (*Trilophodon*) *Ohioticus*, in place in the jaws, although made a subject of special research by Dr. Warren,[5] Dr. Jackson, and myself, upon a large quantity of materials, up to a very late date; nor have they been yet met with in certain species of the *Tetralophodon* group; while, so far from being restricted to species of Mastodon, they have been detected by us in a typical fossil Elephant from India, *E.* (*Loxodon*) *planifrons*, both in the upper and lower jaws, in as great a number as in any known Mastodon.[6] And as regards inferior tusks, although these have been observed in three species of the *Trilophodon* group, and in two of *Tetralophodon*, there are other species in which, among abundant materials, they have not been noticed up to the

[1] Bronn, 'Lethæa Geognostica,' Band ii. pp. 1233 and 1239 (1st ed.).
[2] Id. *loc. cit.* p. 1218.
[3] Id. *loc. cit.* p. 1233.
[4] 'Brit. Foss. Mam.,' p. 274.
[5] Warren, On *Mastodon giganteus*, p. 80.
[6] See vol. i. p. 433.—[Ed.]

present time, even in young individuals, where they might have been with most confidence looked for. This remark applies with especial force to the forms here called *M.* (*Trilophodon*) *Humboldtii*, and to *M.* (*Tetralophodon*) *Sivalensis* and *M.* (*Tetralophodon*) *Arvernensis*.

Swayed by considerations of this nature, and struck more particularly with the identity of general characters and close similarity of form running throughout the whole of the osteology of the species of Mastodon and Elephant, with the exception of the molars and inferior incisors, De Blainville[1] abandoned the idea of there being any sufficient generic difference between the two, and made a retrograde step, arranging all the forms in two divisions, *Lamellidontes* and *Mastodontes*, under the common designation of 'Elephas.' This proposal has deservedly met with little favour among palæontologists and zoologists.

There are characters however, which, when once recognized, are happily of an obvious and readily applicable nature, to distinguish Mastodon from Elephant, and which further enable the palæontologist to break up an unwieldy mass of species into subgeneric groups, that are at the same time natural and convenient. Putting aside for the moment, as extraneous, the consideration of incisors and premolars, and, as in the case of Dinotherium, taking the milk and permanent dentition together, the species of both Mastodon and Elephant ordinarily present six molar teeth from first to last, in the order of horizontal succession—*i.e.*, three deciduous or milk molars, and three true molars. It was stated above, that in the Dinotherium the last milk molar and the antepenultimate or first true molar are invariably characterized by a ternary-ridged formula, or, in other words, that their crowns are divided into three ridges. Applying this criterion in a similar manner to Mastodon, we have found, that not only the last milk molar and first or antepenultimate true molar, but in addition the second or penultimate true molar, being three teeth in immediate contiguity, in all the species (with one remarkable exception) are severally characterized in both jaws by an *isomerous* division of the crown into either 3 or 4 ridges. These three isomerous-ridged teeth may, for convenience of description, be referred to in the aggregate as 'the intermediate molars,' a term which has been applied to them from their position by Fischer and by Laurillard.[2] To the species which present the ternary-ridged formula we have assigned the subgeneric name of *Trilophodon*;[3] and to the quaternary-

[1] De Blainville, Ostéographie: Des Éléphants.

[2] Dictionnaire Universel d'Histoire Naturelle, tom. viii. p. 29.

[3] From τρεῖς and λόφος, three-ridged.

ridged species, *Tetralophodon*.[1] In citing the various forms under discussion in the sequel, these subgeneric terms will, in every case, be used for convenience in designating the species; and the same rule will be followed with the subgeneric divisions of *Elephas*. This will be of obvious use on the present occasion, both as a help to the memory in dealing with a large number of specific names, and as suggestive of broad points of distinction, when referring to the disputed species.

The ternary and quaternary formulæ are, I believe, never found mingled in the intermediate molars of the same species;[2] *i.e.*, a ternary-ridged molar of this series does not occur in the species belonging to *Tetralophodon*, nor a quaternary in *Trilophodon*. The ridge-formula indicates also, with unerring certainty, the composition of the crown of the tooth which is immediately in front of, and of that which is immediately behind, the three intermediate molars: the former showing invariably *one* ridge less, and the latter *one* ridge more; that is to say, the penultimate or second milk molar in all the species of *Trilophodon* is invariably two-ridged, and the last true molar four-ridged; while in *Tetralophodon*, in like manner, the former is three-ridged, and the latter five-ridged—making due allowance in the last true molar for the amount of individual variety presented by the greater or less development of the well-known talon complication, and for its being usually more complex in the lower

[1] From τέσσαρες and λόφος, four-ridged. This difference of *three* and *four* ridges was, so far as I am aware, first pointed out as a distinctive character between two European species, namely *Mastodon angustidens* and *M. Arvernensis*, by Von Meyer, as far back as 1834, but without being extended to the three intermediate molars. The name *M. Arvernensis* was applied by him to the Eppelsheim species, *M. longirostris* of Kaup. (Die Fossilen Zahne und Knochen von Georgensgmünd, p. 33). The ridge-formula in the two subgenera is as follows:—

	Milk molars		True molars
In Trilophodon	$\frac{1+2+3}{1+2+3}$	:	$\frac{3+3+4}{3+3+4}$
In Tetralophodon	$\frac{2+3+4}{2+3+4}$	:	$\frac{4+4+5}{4+4+5}$

the numerals exhibiting the ridges in each tooth, exclusive of the 'talons.'

[2] The only apparent exception which has come under my observation occurs in the dentition of the South American species, to which the name of *Mastodon Andium* (Tetralophodon of our arrangement) has been restricted by the French palæontologists, Laurillard and Gervais, as distinct from *M. Humboldtii* (Trilophodon). In this species the last ridge in most of the intermediate molars is considerably reduced in size; and the teeth have been, in consequence, described by Gervais (Zoologie de l'expédition dans l'Amérique Méridionale par Le Comte de Castelnau, p. 19) as three-ridged. The specimens represented by him, figs. 2 and 5 of Plate v. in the 'Voyage de Castelnau,' the former an antepenultimate upper true molar, and the latter a penultimate lower, are distinctly four-ridged, while the last lower milk molar (fig. 4) is apparently three-ridged, with a large talon. My attention was directed to the subject by M. Lartet. More specimens are required for the exact determination of the point than yet exist in any of the European museums; *i.e.*, whether in the intermediate molars of the form called *M. Andium* the ternary and quaternary formulæ are mingled. Nine-tenths at least of the specimens of South American Mastodons in the British Museum belong to the other species, *M.* (*Trilophodon*) *Humboldtii*.— July 1857, H. F. (See p. 15, note 3, and also vol. i. p. 106.—Ed.)

jaw. The 'ridge-formula' thus determines, with precision, five out of the series of six molars developed in horizontal succession in all the true Mastodons.

For reasons which will be explained in the sequel, it would seem that there has existed in nature another subgeneric group of *Mastodon*, of which only a single form is at present known, in which the crowns of the 'intermediate molars' are divided upon a quinary ridge-formula. This group in our arrangement would be characterized, in harmony with the others, as *Pentalophodon*; and it may with some confidence be predicated that, when the dentition shall have been well determined, the second milk molar will present four ridges, and the last true molar six ridges in the upper jaw.

The Elephants, on the other hand, are distinguished from the Mastodons by the absence of an isomerous ridge-formula to the three intermediate molars of the upper and lower jaws; and by the circumstance that the ridges, instead of being limited to three or four, range from six up to an indefinite number in these teeth, in the different groups of species. We have found that the numerous forms, fossil and recent, may be conveniently arranged in three natural subgeneric groups, founded upon the ridge-formula, in conjunction with certain other dental characters.

In the first of these groups, corresponding with the forms collectively designated *Mastodon Elephantoïdes* by Clift, the ridge-formula may be said to be *hypisomerous*, as the difference between the crowns of any two of the consecutive intermediate teeth does not exceed more than one ridge, and the ciphers range in the different species from 6 to 8. The ridges are not more elevated than in the true Mastodons, so that, when the teeth are sawn through longitudinally, the section yields a succession of salient and re-entering angles, the height of the chevron-shaped ridges not much exceeding the width of their base. The enamel is very thick, and the coronal interspaces in most of the species are filled up with an enormous quantity of cement. To this group we have assigned the subgeneric name of *Stegodon*.[1] It is limited to extinct forms confined at present to the Indian Tertiaries. The Stegodons constitute the intermediate group of the Proboscidea from which the other species diverge through their dental characters, on the one side into the Mastodons, and on the other into the typical Elephants.

In the second group, which includes the species allied to the African Elephant, the ridge-formula is also hypisomerous, as in the Stegodons, the ciphers ranging from 7 to 9 in the

[1] From στέγη *tectum*, and ὀδοὺς *dens*, having reference to the gable-end form of the section of the ridges.

crown ridges of the intermediate molars of the different species. But the colliculi, instead of yielding a gable-shaped or 'tectiform' section as in the Stegodons, are much more elevated and compressed, so that when the teeth are sawn longitudinally and vertically, the ridges present the appearance of elongated wedges, with thinner plates of enamel. For this subgeneric group, the name of *Loxodon*,[1] first indicated by Frederick Cuvier, has been adopted. It comprises both extinct and living species.

The last group, which is numerically the largest and most important, including the Elephants with thin-plated molars, as in the existing Asiatic species, is characterized by the ridge-formula being regulated in the 'intermediate molars,' not by hypisomerous ciphers, but by progressive increments (*anisomerous*), which may be expressed (*e.g.* for the Indian Elephant) by the series 12 + 14 + 18.[2] These ciphers, be it remarked, are not put forward as being rigidly exact in every case; for the higher the numerical expression of the ridge-formula in the species, the more liable to vary within certain limits, dependent on the race, sex, and size of the individual, is the number of the plates; and they do not rigidly correspond throughout in the upper and lower molars, the latter often exhibiting an excess. But it may safely be asserted that the numbers are never transposed or reversed—*i.e.*, the younger tooth among the 'intermediate molars' never normally exhibits in the same individual a higher number than the older; the increments may not always be symmetrical, but they are invariably more or less progressive. For this subgeneric group we propose the term of *Euelephas*.[3]

The following systematic Diagnosis of the genera *Mastodon* and *Elephas* was prepared as an Appendix, but its insertion

[1] From λοξὸς *obliquus*, and ὀδοὺς *dens*, having reference to the rhomb-shaped discs of the worn molars; an adaptation of the term '*Loxodonta*' proposed by Fred. Cuvier ('Hist. Naturelle des Mammifères,' tom. iii. Article 'Éléphant d'Afrique.' 1835).

[2] The illustration in this case is taken from the existing Indian Elephant, *E.* (*Euelephas*) *Indicus*, in which the ridge-formula of the whole series is nearly thus:—

Milk molars — True molars

$$\frac{4+8+12}{4+8+12} : \frac{}{14+18+24-27}*$$

the numerals representing the ridges in each tooth, exclusive of the talons. A progressive increment runs throughout the series; but the selected numbers refer only to the 'intermediate molars.' In the species which approach nearest to *Loxodon*, the numerical expression of the ridge-formula is lower.

[3] From εὖ *bene*, and ἐλέφας, having reference to the typical Elephants most familiarly known. In the illustrations of the 'Fauna Antiqua Sivalensis,' the term *Elasmodon* was applied to this subgeneric group; but, the designation of *Elasmodus* having been preoccupied by Sir Philip Egerton for a series of fossil fish (Proc. Geol. Soc. vol. iv. p. 163, 1843), to prevent confusion, the term of *Euelephas* has been substituted for it.

* The ridge-formula for the true molars was subsequently altered to $\frac{12+16+24}{12+16+24-27}$. See note to description of *Elephas antiquus*, and Memoir on *E. Columbi*.—[Ed].

in this place more conveniently elucidates the subject-matter of this memoir.

Genus MASTODON (Cuv.).

Formula Dentium deciduorum.—*Primores* $\frac{1}{1}$ vel $\frac{1}{0}$; *Laniarii* $\frac{0}{0}$; *Molares* $\frac{3}{3}$ = 8–7.

Formul. Dent. persist.—*Primor.* $\frac{1}{1}$ vel $\frac{1}{0}$; *Lan.* $\frac{0}{0}$; *Præmol.* $\frac{2}{2}$ ($\frac{1?}{1}$) vel $\frac{0}{0}$; *Molares veri* $\frac{3}{3}$ = 12–8.

Primores eburnei plerumque exserti: superiores maximi vario modo porrecti, inferiores horizontales vel leviter deflexi, recti, minores. *Molares* complicati, tritores; *coronidis* rimâ longitudinali obsolete bifidæ *colliculi* concavi e tuberculis mammillaribus per paria transverse aut alternatim dispositis, constantes: *adamante* crasso, *cæmento* in valliculis parco aut subnullo. *Præmolares* aut cæteris formâ simpliciores minores, aut nulli. *Molares veri* 3, deinceps majores, altero alterum extrusum a tergo vicissim excipiente, demum utrinque solitarii.—*Molares* 3 utrinque *intermedii* (nempe deciduorum postremus et verorum antepenultimus penultimusque) *colliculis* isomeris aut 3, 4, aut 5 conformes.

Proboscis longissima, prehensilis. *Corpus* vastum artubus elevatis insistens. *Pedes* 5-dactyli.

Subgenus 1. TRILOPHODON.—Dentium molarium 3, utrinque intermediorum coronis colliculis 3.

Subgenus 2. TETRALOPHODON.—Dent. molar. 3, utrinque intermediorum coronis colliculis 4 (raro 5).

Observations.—The adult dentition varies much in the different species of the genus; the premolars and inferior incisors being inconstant. The typical complete formula is best shown by *M.* (*Triloph.*) *angustidens* of Simorre:—Incis. $\frac{1}{1}$; Can. $\frac{0}{0}$; Premol. $\frac{2}{2}$; Mol. $\frac{3}{3}$ = 12, being identical with that of *Dinotherium*, so far as the dentition of the latter has been determined—*i.e.*, Incis. $\frac{1?}{1}$; Can. $\frac{0}{0}$; Premol. $\frac{2}{2}$; Mol. $\frac{3}{3}$ = 12; the only question being in regard of upper incisors, the presence or absence of which has not yet been clearly ascertained in *Dinotherium*. The affinity indicated by the agreement in number is corroborated by the last milk molar and antepenultimate true molar being three-ridged, alike in *Dinotherium* and in the section of *Mastodon* here called *Trilophodon*. Premolars have not been met with in *M.* (*Triloph.*) *Ohioticus*, which, counting both sides of both jaws, has eight

molars less in the adult state than *M.* (*Triloph.*) *angustidens*; nor have they been observed in *M.* (*Triloph.*) *Humboldtii.* They occur probably in *M.* (*Triloph.*) *Tapiroïdes.* Their presence or absence has not yet been ascertained in the other species of *Trilophodon.* These teeth have been observed *in situ* in the upper and lower jaws of *M.* (*Tetraloph.*) *longirostris*, and in the upper of *M.* (*Tetraloph.*) *Arvernensis.* They have not yet been seen *in situ* in the other species of *Tetralophodon.* Inferior incisors have been discovered in *M.* (*Triloph.*) *angustidens*, *M.* (*Triloph.*) *Ohioticus*, and *M.* (*Triloph.*) *Tapiroïdes*; and also in *M.* (*Tetraloph.*) *Andium* and *M.* (*Tetraloph.*) *longirostris*, in the first of which they occasionally attain a very large size. They do not appear to occur ever in *M.* (*Tetraloph.*) *Sivalensis*, nor in *M.* (*Tetraloph.*) *Arvernensis.* Their presence or absence in the two other species of *Tetralophodon* has not yet been satisfactorily determined. The ridge-formula, as being respectively ternary in *Trilophodon*, and quaternary in *Tetralophodon*, is very constant, the only doubtful case being presented by the form or forms named *Mastodon Andium* by the French palæontologists. Cement, although quantitatively inconspicuous in most of the species of both subgenera, is present in considerable abundance in the valleys of the crowns of *M.* (*Tetralophodon*) *Perimensis* and in *M.* (*Triloph.*) *Humboldtii.* In the former it fills up the bottom of the interstices between the mammillæ. The transverse or alternate direction of the mammillæ of the ridges, and the open or interrupted nature of the valleys connected therewith, are not equally defined in all the species, intermediate stages being met with. But the ridges are invariably transverse and the valleys open in *M.* (*Triloph.*) *Borsoni*, *Ohioticus*, and *Tapiroïdes*, and in *M.* (*Tetraloph.*) *latidens*; while the mammillæ are constantly more or less alternate, and the valleys interrupted, among the Trilophodons in *M.* (*Triloph.*) *angustidens*, *Humboldtii*, and *Pandionis*; and among the Tetralophodons in *M.* (*Tetraloph.*) *Sivalensis* and *Arvernensis.* The most complex crowns are presented in the Trilophodons by *M.* (*Triloph.*) *Pandionis* (an Indian fossil species recently discovered, and as yet undescribed) and *M.* (*Triloph.*) *Humboldtii*, and among the Tetralophodons by *M.* (*Tetraloph.*) *Sivalensis* and *Arvernensis.* The upper adult molars in several of the species—*e.g.*, *M.* (*Triloph.*) *angustidens* and *M.* (*Tetraloph.*) *Andium*—were invested with a longitudinal belt of enamel, disposed more or less spirally, and reaching the apex. The lower incisors, according to Lartet, are constantly devoid of any such belt. In *M.* (*Triloph.*) *angustidens* inferior incisors would appear to have been common to males and females, and not to have been a mark merely of sexual difference.

Mastodon Sivalensis, although with five-ridged 'intermediate molars,' is provisionally included under *Tetralophodon*.

Genus Elephas (Linn.).

Form. Dent. decid.—*Primor.* $\frac{1}{0}$; *Lan.* $\frac{0}{0}$; *Mol.* $\frac{3}{3}=7$.

Form. Dent. persist.—*Primor.* $\frac{1}{0}$; *Lan.* $\frac{0}{0}$; *Præmol.* $\frac{2}{2}$ vel $\frac{0}{0}$; *Mol.* $\frac{3}{3}=11–7$.

Primores eburnei plerumque exserti, sursum et antrorsum adscendentes. *Molares* aut complicati aut lamellosi, tritores; *coronidis* longitudinaliter integræ *colliculi* convexi e tuberculis mammillaribus, aut laminis cuneiformibus vel compressis digitatis transversis, constantes: *adamante* illis crasso, his attenuato, *cæmento* in valliculis copioso. *Præmolares* rarissime utrinque 2 (sæpius nulli), cæteris forma simpliciores, minores. *Molares veri* 3, deinceps majores, altero alterum extrusum a tergo vicissim excipiente, demum utrinque solitarii.—Molares 3 utrinque intermedii (nempe deciduorum postremus et verorum antepenultimus penultimusque) *colliculis* supra 5 (6–18), aut hypisomeris, aut anisomeris.

Proboscis longissima, prehensilis. *Corpus* vastum artubus elevatis insistens. *Pedes* 5-dactyli.

Subgen. 1. Stegodon.—Dentium molarium 3 utrinque intermediorum coronis complicata colliculis hypisomeris (*e.g.* 7 + 7 + 8), mammillatis, tectiformibus. Præmolares nondum observati.

Subgen. 2. Loxodon.—Dent. molar. 3 utrinque intermedior. coronis lamellosa colliculis hypisomeris (*e. g.* 7 + 7 + 8), cuneiformibus. Præmolares raro utrinque 2.

Subgen. 3. Euelephas.—Dent. molar. 3 utrinque intermedior. coronis lamellosa colliculis deinceps numero auctis, anisomeris (*e. g.* 12 + 14 + 18), attenuatis, compressis. Præmolares nulli.

Observations.—The adult dentition of the Elephants, although typically more aberrant, is more constant than that of the Mastodons. Inferior incisors are wanting in all the species, fossil and recent, at present known; and premolars have as yet only been met with in a single form, *E.* (*Loxodon*) *planifrons.* The common formula is, Incis. $\frac{1}{0}$; Can. $\frac{0}{0}$; Premol. $\frac{0}{0}$; Mol. $\frac{3}{3}=7$: but in this exceptional case, the premolars are as numerous as in any species of

Genera, Subgenera, and Species			Spec.	
MASTODON.	Subgen. 1. TRILOPHODON.	(*a.*) Colliculi acuti valliculæque transversi . .	1. M. (Trilophodon)	Borsoni (*I. Hays*). .
			2. M. (Triloph.)	Tapiroïdes (*Cuv.*) . .
			3. M. (Triloph.)	Ohioticus (*Blumb.*) .
		(*b.*) Colliculi obtusi alternatim mammillati, valliculæ interruptæ . .	4. M. (Triloph.)	angustidens (*Cuv.*) .
			5. M. (Triloph.)	Pyrenaicus (*Lart. MSS.*)
			6. M. (Triloph.)	Humboldtii (*Cuv.*) .
			7. M. (Triloph.)	Pandionis [2] (*Falc.*) .
	Subgen. 2. TETRALOPHODON.	(*c.*) Colliculi obtusi valliculæque transversi . .	8. M. (Tetralophodon)	longirostris (*Kaup*) .
			9. M. (Tetraloph.)	latidons (*Clift*) . .
		(*d.*) Colliculi obtusi alternatim mammillati, valliculæ interruptæ . . .	10. M. (Tetraloph. ?)	Andium (*Cuv.*) [3] . .
			11. M. (Tetraloph.)	Perimensis (*Falc.& Caut.*)
			12. M. (Tetraloph.)	Arvernensis (*Croizet and Jobert*) .
		(*e.*) Colliculi numero 5, obtusi alternatim mammillati, valliculæ interruptæ	13. M. (Tetraloph.)	Sivalensis (*Falc. & Caut.*)
ELEPHAS.	Subgen. 1. STEGODON.	(*a.*) Colliculi circiter 6, cæmento in valliculis parco .	1. E. (Stegodon)	Cliftii (*Falc. & Caut.*) .
		(*b.*) Colliculi 7–8, cæmento in valliculis copiosissimo .	2. E. (Stegod.)	bombifrons (*Falc.& Caut.*)
			3. E. (Stegod.)	Ganesa? (*Falc. & Caut.*)
			4. E. (Stegod.)	insignis (*Falc. & Caut.*)
	Subgen. 2. LOXODON.	(*c.*) Colliculi grosso digitati, adamante crasso . .	5. E. (Loxodon)	planifrons (*Falc. & Caut.*)
			6. E. (Loxod.)	meridionalis (*Nesti*)
		(*d.*) Colliculi medio angulatim dilatati, machæridibus per detritionem rhomboideis . . .	7. E. (Loxod.)	priscus (*Goldf.*) [4] . .
			8. E. (Loxod.)	Africanus (*Blumb.*) .
	Subgen. 3. EUELEPHAS.	(*e.*) Colliculi subremoti adamante crassiusculo .	9. E. (Euelephas)	Hysudricus (*Falc.& Caut.*)
		(*f.*) Colliculi approximati, medio leviter dilatati, machæridibus undulatis .	10. E. (Eueleph.)	antiquus (*Falc.*) . .
			11. E. (Eueleph.)	Namadicus (*Falc.& Caut.*)
		(*g.*) Colliculi approximati, machæridibus valde undulatis	12. E. (Eueleph.)	Columbi (*Falc.*) . .
			13. E. (Eueleph.)	Indicus (*Linn.*) . .
			14. E. (Eueleph.)	Armeniacus (*Falc.*) .
		(*h.*) Colliculi confertissimi, adamante valde attenuato, machæridibus vix undulatis	15. E. (Eueleph.)	primigenius (*Blumb.*) .

[1] The so-called *Mastodon Australis* of Owen Dr. Falconer subsequently (as indeed he had done in 1846; see vol. i. p. 106) referred to *M. Andium* instead of to *M. Humboldtii*. (See notes to memoir on *Elephas Columbi*.)—[ED.]

[2] *Extract of letter from Dr. Falconer to M. Lartet, December* 18, 1856:—'I have discovered a new species of *Trilophodon* from India, *Triloph. Pandionis*. It is not from the Sewalik Hills. It is allied to *Mastodon angustidens* and *M. Humboldtii*.' (See also vol. i. p. 124.)—[ED.]

Geological Age	Country	Remarks
Pliocene	France; Piedmont	Syn. *Mastodon Buffonis* (Pomel)
Upper Miocene	France; Switzerland	Syn. *M. Turicensis* (Schinz, juxta Von Meyer)
Post-Pliocene	North America	Syn. *M. maximus* (Cuv.); *M. giganteus* (Auctorum). (Pl. I. fig. 2, and Pl. II. fig. 2.)
Upper Miocene	France; Germany; Switzerland	Syn. *M. Simorrense* (Lart.); *M. Cuvieri* (Pomel). (Pl. II. fig. 3, and Pl. III. figs. 3 and 4)
Upper Miocene	France	
Post-Pliocene?	South America	An Syn. *M. Australis* of Owen (?); of reputed Australian origin!! [1]
Pliocene?	Southern India	Imperfectly known, but very distinct as a species; is the only Indian *Trilophodon* (Pl. XXXIV. figs. 6 & 7 of vol i.)
Upper Miocene	Germany: Eppelsheim	(Pl. II. fig. 8, and Plate III. figs. 1 and 2)
Miocene	Southern India; Ava	(Pl. II. fig. 9)
Pliocene?	South America	Large inferior incisors, one or two. The subgenus doubtful. (Pl. I. fig. 3, Pl. II. fig. 4, and Plate VIII. of vol. i.)
Miocene	Southern and Western India	Hitherto found only in Perim Island. (Pl. I. fig. 4, Pl. II. fig. 5, and Pl. IX. of vol. i. figs. 3–6)
Pliocene	England; France; Italy	Syn. *M. brevirostre* (Gervais). (Pl. II. fig. 7, and Plate IV.)
Miocene	India: Sewalik Hills	The only known species indicating a Pentalophodon-type. (Pl. I. fig. 5, Pl. II. fig. 6, Plate IX. of vol. i. figs. 1 and 2, and Pl. X. of vol. i.)
Miocene	Southern India; Ava	Syn. *M. latidens* (Clift. pro parte). (Pl. II. fig. 10, and Pl. V. figs. 1 & 2)
Miocene	India: Sewalik Hills	(Pl. I. fig. 6, and Plate II. fig. 11)
Miocene	India: Sewalik Hills	Distinctness as a species doubtful. (Pl. I. fig. 7, and Pl. II. fig. 12)
Miocene and Pliocene	Sewalik Hills and Central India	Found in both the Valley of the Nerbudda (*Pliocene*) and Sewalik Hills (*Miocene*). (Pl. I. figs. 8, 8 *a*, & 8 *b*, Pl. II. figs. 13 & 13 *a*, and Pl. V. figs. 3 & 4)
Miocene	India: Sewalik Hills	The only Elephant in which premolars have been met with. (Pl. I. fig. 9, Pl. II. fig. 14, and Pl. VI. fig. 2)
Pliocene	England; France; Italy	(Pl. I. fig. 11, Pl. II. fig. 16, and Pl. VIII.)
Pliocene	England; Lombardy	Imperfectly known. Fossil remains rare. (Pl. VII.)
Existing	Africa	(Pl. I. fig. 10, Pl. II. fig. 15, and Pl. VI. fig. 1)
Miocene	India: Sewalik Hills	(Pl. I. figs. 12 & 12 *a*, and Pl. II. figs. 17 & 17 *a*)
Pliocene	England; France; Italy	(Pl. IX.)
Pliocene	Central India	Restricted to the *Pliocene* Fauna of the Valley of the Nerbudda, Central India. (Pl. I. fig. 13, and Pl. II. fig. 18)
Post-Pliocene?	Mexico; Georgia; Alabama	An Syn. *E. Jacksoni*? (Silim. Journ. 1838, vol. xxxiv. p. 363). (Pl. X. figs. 1 & 2)
Existing	India	Syn. *E. Sumatranus* (Temminck). (Pl. I. figs. 14, 14 *a*, & 14 *b*, Pl. II. figs. 19, 19 *a*, & 19 *b*, and Pl. VI. fig. 3)
?	Armenia: Erzeroom	In the Brit. Mus. Coll. Discovered between Erzeroom and Moosh in 1856. The molar plates closely approximated, and the enamel edges very undulated (Pl. X. fig. 3)
Post-Pliocene	Europe, Asia, and North America	(Plate I. fig. 15, Pl. II. fig. 20, and Pl. VI. fig. 4.)

[1] Dr. Falconer was afterwards inclined to think that *Mastodon Andium* would have to be replaced in the subgenus *Trilophodon*, in which he had placed it in 1846. (See vol. i. p. 99, and memoir on *Elephas Columbi*.)—[ED.]

[2] *Loxodon priscus* was afterwards regarded by Dr. Falconer as a form of *Elephas antiquus*. *E. Melitensis*, Falc. (Plates XI. and XII.), however, or the pigmy Fossil Elephant of Malta, was subsequently added by him to the subgenus *Loxodon*.—[ED.]

Mastodon, the formula being, Incis. $\frac{1}{0}$; Can. $\frac{0}{0}$; Premol. $\frac{2}{2}$; Mol. $\frac{3}{3}$ $=11$. It exceeds the rest of the species by 8 molars in both jaws, as *M.* (*Triloph.*) *angustidens* exceeds *M.* (*Triloph.*) *Ohioticus*. A longitudinal belt of enamel has not yet been observed on the tusk of any Elephant. The molars are presented under two forms: in the subgenus *Stegodon* as 'Dentes complicati,' resembling those of *Mastodon* in the folded form of their crown-eminences, and as 'Dentes lamellosi' in *Loxodon* and *Euelephas*. The convexity of the crown-ridges, and the absence of the longitudinal, mesial, bipartient cleft, so characteristic of the true Mastodons, are very constant in the Elephants, the only exception, limited to the latter character, being indistinctly seen in an *E.* (*Stegod.*) *Cliftii*. The passage from the Stegodons into the Loxodons is effected through *E.* (*Steg.*) *insignis* and *E.* (*Loxod.*) *planifrons*, and from the Loxodons into *Euelephas* through *E.* (*Lox.*) *meridionalis* and *E.* (*Euel.*) *Hysudricus*. The anisomerous ridge-formula in *Euelephas* is not numerically the same in all the species, being in some higher, in others lower; but they all agree in exhibiting progressive increments. The amount of undulation presented by the worn edges of the enamel plates furnishes a good means of distinguishing the nearly allied fossil species in *Euelephas*.

The distinctive and specific characters of Mastodon and Elephant.—A safe criterion by which to test the soundness of any proposed arrangement in Natural History is, that the technical characters, however abridged, should be exponents, so to speak, of the natural and serial affinities, and in nowise at variance with them. If this test be applied to the ridge formula, as a consistent basis for the arrangement of the Mastodons and Elephants, it will, we believe, not be found wanting: thus the Mastodons ranged under *Trilophodon* and *Tetralophodon* include all the Elephantoïd species which have the crowns of the molars comparatively simple and uniformly divided into two subequal divisions by a longitudinal line or cleft; the ridges limited in number, each with fewer mammillary eminences, and invariably more or less concave across; the enamel thick, and in conical or compressed points; and the valleys between the ridges deep and empty, or with but a sparing quantity of cement. The Elephants, on the other hand, as restricted by the ridge-formula and ranged under *Stegodon*, *Loxodon*, and *Euelephas*, include all the Proboscidean species which have the crowns of the molars more complex, and usually wanting in a longi-

tudinal line of division; the ridges more numerous and less definite, each being composed of a greater number of mammillary or digital points, which are most elevated in the middle, rendering the ridges convex across, instead of concave; the processes of enamel thinner, higher, and more divided; and the deep narrow valleys between them entirely filled up with cement. The limitations of the two genera agree pretty well with the views generally entertained by palæontologists regarding them; with the exception, that the group comprising the collective *Mastodon Elephantoïdes* of Clift, and by some called '*Transitional Mastodons*,'[1] is here regarded as more properly belonging to the Elephants.

A Synoptical Table[2] is annexed of the species of *Mastodon* and *Elephas*, ranged under subgenera, after the manner here indicated. The species were first determined or adopted after a careful examination of all the original materials accessible, in the foreign collections already referred to (p. 4), or in various museums in the United Kingdom. They were then arranged serially, according to their relative affinities, as indicated by the molar teeth; the common characters were next analyzed, to furnish a key for breaking up the mass of species into groups representing genera and subgenera; and the Synoptical Table shows the result. It is put forward as exhibiting a fair representation of the subject, so far as the materials and state of knowledge at the present time admit, but with no pretension to being either unexceptionable or complete. The progress of investigation, by the discovery either of new forms, or of more abundant materials of the species which are now the most imperfectly determined, will in all probability modify more or less, or break down, any generic or subgeneric limitations that may be at present devised. For the daily experience of every department of Mammalian Palæontology tends to show that, while the characters of species are persistent over wide areas and through long periods of time, genera are nothing more than ideal or conventional centres, around which groups of species are arranged, subject to incessant modifications through the discovery of new forms. It would be foreign to the main object of the present communication, and beyond the limits within which it is necessarily restricted, to discuss in detail the grounds on which the arrangement is founded. As this will be done more fully elsewhere, I shall content myself here with stating them in a general way, and with indicating where the assailable points are. Although the Mastodon of

[1] Owen's 'Odontography,' p. 624. (See vol. i. p. 68.—Ed.)

[2] In Plates I. and II. also are figured in outline the skulls of the several species of Mastodon and Elephant.—[Ed.]

North America and the Mammoth are so widely different in the form of their molar teeth that they must be ranked under distinct genera, the intermediate gradations are so complete as to establish a passage from the one into the other. Failing the characters of premolars and inferior incisors, previously relied upon as distinctive of the Mastodons, and abundant cement as distinctive of the Elephants, the constancy of the ridge-formula in being isomerous (whether ternary, quaternary, or quinary) in the intermediate molars, appeared to furnish a sufficient technical demarcation between *Mastodon* and *Elephas*, and to subdivide the former satisfactorily into the natural subgeneric groups of *Trilophodon* and *Tetralophodon*. It remains to be seen whether there is any intermediate species in which the characters of these two groups are blended.

Mastodon Sivalensis is regarded as having five ridges to the 'intermediate molars,' instead of four; but this remarkable character being restricted at present to a single species, it was deemed inexpedient to form a systematic section for it alone, and it is ranged at the end of the Tetralophodons.

Although a mesial, bipartient, longitudinal cleft along the summit of the crown is very common in the molars of most of the species of Mastodon, and usually absent in the Elephants, there is one species of the former, *M.* (*Triloph.*) *Borsoni*, in which the cleft is so obsolete, that Isaac Hays[1] founded the specific character upon the supposed absence of this cleft. But the cleft, although but slightly pronounced, is distinctly present in unworn germ-teeth of this form; and it is even visible in the original molar described by Abbé Borson, upon which Dr. Hays relied for its absence.

The plurality of the species in the first subgeneric group of *Elephas*, namely *Stegodon*, are sufficiently distinguished from the Mastodons by the higher numerical expression of the crown-formula, in showing 7 or 8 ridges instead of 3 or 4; by the great quantity of laminated cement which fills the transverse valleys; by the ridges being convex, as in the typical Elephants; by the greater number of points to each ridge; and by the absence of a mesial dividing furrow. But in one of the species, *E.* (*Stegodon*) *Cliftii*, there is an obsolete indication of this furrow; and its affinity to the Mastodon is further evinced by the low or senary expression of the ridge-formula. This species constitutes a frontier form, through which the passage between the two genera is effected; but the details of the other dental characters show that it is most nearly allied to the Stegodons, and the characters of the subgeneric group were constructed to admit of

[1] Transactions of the American Philosophical Society, ser. 2, vol. iv. p. 334.

its reception among them. Two of the Loxodons, namely, *E.* (*Lox.*) *planifrons* and *E.* (*Lox.*) *Africanus*, have a ridge-formula which is identical or nearly so with that of *Stegodon insignis*; but the separation of the group is indicated by the great increase of vertical height in the colliculi, and by the layers of enamel assuming the character of plates, instead of the mastoid eminences of *Stegodon*. *E.* (*Lox.*) *meridionalis* has a higher number of plates in the 'intermediate molars' than those two species, and constitutes a frontier form, leading towards the next group, *Euelephas*. But the ridge-formula in this form would appear to be hypisomerous, and the aggregate characters indicate its position among the Loxodons. The majority of the species in the group *Euelephas* are well marked by the progressive increments and high numerical expression of the crown-ridges of the intermediate molars, by the great vertical height of the colliculi, and the attenuated plates of enamel. One species among them, *E.* (*Euleph.*) *Hysudricus*, constitutes a frontier form leading towards *E.* (*Lox.*) *meridionalis*. More ample details respecting the Elephants will be given in the second part of this memoir, when treating of the European fossil species.

To revert specially to the Mastodons, *Trilophodon* and *Tetralophodon* (including under the latter the exceptional five-ridged *Mastodon Sivalensis*), as regards the number of forms at present known, are of nearly equal value, the former in our view comprising 7, and the latter 6, well-marked species; and they are each divisible into two parallel subordinate groups, the exact appreciation of the characters of which is of much service in the determination of the European fossil species. In the one series, the ridges are broad, transverse, more or less compressed into an edge, with the valleys open throughout and uninterrupted by subordinate tubercles: these are well represented in *Trilophodon* by *M.* (*Triloph.*) *Ohioticus*, and in *Tetralophodon* by *M.* (*Tetraloph.*) *latidens*. In the other series, the ridges are composed of blunt conical points, which are fewer in number, more elevated, and flanked in front and behind by one or more subordinate outlying tubercles, which disturb the transverse direction of the ridges and block up the valleys, interrupting their continuity across. This series is represented in *Trilophodon* by the Miocene European species, *M.* (*Triloph.*) *angustidens*, and in *Tetralophodon* by the Pliocene species, *M.* (*Tetraloph.*) *Arvernensis* of the Crag. (See Plates III. & IV.) The species with transverse compressed ridges, in both subgenera, may be compared with *Dinotherium* as regards their molar crowns, and the other series with *Hippopotamus*.

The European fossil species of *Mastodon* at present known are the following,[1] all of which are of Miocene age, with the exception of *M.* (*Trilophodon*) *Borsoni* and *M.* (*Tetralophodon*) *Arvernensis*, which are Pliocene:—

M. (Triloph.) Borsoni, *Isaac Hays* (Pliocene).
M. (Triloph.) Tapiroïdes, *Cuvier*.
M. (Triloph.) angustidens, *Cuvier*, pro parte.
M. (Tetraloph.) longirostris, *Kaup*.
M. (Tetraloph.) Arvernensis, *Croizet & Jobert* (Pliocene).

The British fossil Mastodon, and its comparison with M. angustidens, M. Arvernensis, and M. longirostris.—The remains of only one species of *Mastodon* have hitherto been discovered in the British Isles, in what is called the Older Pliocene 'Red Crag,' at Felixstow and Sutton in Suffolk, and in the Newer Pliocene, 'Fluvio-marine,' or 'Mammaliferous Crag,' in various localities near Norwich and in Suffolk. I shall now endeavour to ascertain what this species is; and as I consider that the question is one of considerable importance, as a turning-point upon which the independent character of the British Pliocene fauna hangs—that is to say, whether it is distinct, or merely a long-lived offset from the Miocene—I shall not hesitate to enter at length upon the details calculated to throw light upon the subject.

Professor Owen is the only English palæontologist who has undertaken to identify and describe in connexion all the Mastodon remains of the Crag, which he has done very fully in his valuable work 'On the British Fossil Mammalia,' published in 1846. He there designates the species *Mastodon angustidens* or *Mastodonte à dents étroites* of Cuvier; and gives as synonyms, in his opinion, *M. Arvernensis* of Croizet and Jobert, and *M. longirostris* of Kaup. He heads the chapter with a woodcut of the upper and lower jaws of the Eppelsheim *M. longirostris*, after Kaup, under the name of *Mastodon angustidens*; and in his description of the dentition of *M. angustidens*, in the 'Odontography,'[2] he draws his details of the various teeth indifferently from the three nominal species above mentioned—namely, *M. angustidens*, *M. longirostris*, and *M. Arvernensis*. In his memoir on the Crag

[1] M Aymard has added largely to the nomenclature of the Proboscidea by creating a new genus, and new species for the remains found in the Velay and Auvergne—viz. *Anancus macroplus*, as a generic form distinct from Mastodon, and *Mastodon Vellavus* and *M Vialetti*, regarded by Pomel as synonyms of *M Borsoni*, also a fossil Elephant, *E giganteus*, Aym But the specific distinction of these nominal species is exceedingly doubtful (*vide* Bulletin de la Société Géologique, and Congrès Scientifique de France, 1855, p. 276) The species referred to in a preceding page as having been made out by M. Lartet has not yet been published

[2] *Op cit* p 619 *et seq.*

Mammalia, contained in the 47th number of the 'Quart. Journ. Geol. Soc.,' published in August of the present year (1857), he reiterates the opinion that *Mastodon angustidens* and *Mastodon longirostris* are synonyms of the English Crag species. Any opinion emanating from so distinguished a palæontologist as Professor Owen, and repeated by him after mature study, at various intervals, between 1843 and 1856, must necessarily carry great weight with it. The first point, therefore, to determine is, what is the species to which Cuvier's name of *M. angustidens* is legitimately applicable?

Mastodon angustidens.—The fluviatile or lacustrine Molasse of the basin of the Sub-Pyrenees has from a very remote time been worked, at Simorre, by mines for what was called the '*Turquoise de nouvelle Roche,*' this substance being the ivory of Mastodon-tusks chiefly, highly injected with a metallic infiltration, so as to simulate the natural mineral Turquoise.[1] The excavations brought to light the numerous Miocene remains found in this rich depôt, and among others the molars of Mastodon. These were vaguely referred to by the old naturalists under the name of the 'Animal de Simorre.'[2] Some of them found their way, in the progress of time, to the Museum of Natural History in Paris, about the middle of the last century; and Daubenton described them under the title of 'petrified teeth having relations to those of Hippopotamus,' to which indeed, in some important respects, they bear a very striking analogy. Cuvier, having established his 'grand Mastodonte' of North America, next directed his attention to the European remains of the genus, the first of which he published under the title of 'Mastodonte à dents étroites,' or *M. angustidens*. It has been proved upon the clearest evidence, by various palæontologists, and admitted, among others, by his devoted friend and follower Laurillard,[3] that Cuvier has included more than one species under this nominal designation of *M. angustidens*. It is requisite, therefore, to ascertain precisely what were the original types which suggested a name of such palpable signification to a shrewd and philosophical observer like Cuvier. On referring to his original memoir, it will be found that Cuvier commences,[4] as his first illustration, with a description of one of the Simorre molars previously described by Daubenton. The second piece is the Dax specimen from near Sort, Département des Landes, and obtained from a fluvio-marine Molasse

[1] Reaumur, 'Mém. de l'Acad. des Sciences,' 1715, p. 174; and Lartet, 'Quelques Aperçus Géologiques dans le Département du Gers,' p. 19.

[2] Dictionnaire Universel d'Histoire Naturelle, tom. viii. pp. 29, 30.

[3] Id. *op. cit.* p. 24.

[4] Annales du Muséum, tom. viii. p. 412.

formation, probably of the same age as the Simorre lacustrine beds. The third specimen is a South American fragment, brought to Europe by Humboldt, which has no connexion with the European species: on this head all later palæontologists who have investigated the subject, without exception (exclusive of mere compilers), are agreed; among others, Laurillard,[1] who identifies it with *M. Andium*, as restricted by him. The fourth specimen which Cuvier quotes is another Simorre fossil. The sixth, a very important and characteristic specimen, is from the same locality. Now, all these Simorre specimens, with the exception of the third—which is a premolar, and therefore a normal exception—are characterized by having their crowns divided into three principal ridges. 'It is therefore,' as we have elsewhere[2] stated, 'to a species having the intermediate molars distinguished by a ternary division of the crown (as in *M. Ohioticus*) that the specific name of *M. angustidens* is strictly applicable, so far as priority of description and reference to original types can be taken as the guides to a decision on the point.' (See Plate III. figs. 3 & 4.)

Since the time of Cuvier, Simorre and Sansan have become classical palæontological ground, through the important discoveries made by M. Lartet of the first-announced fossil monkey in Europe, of *Macrotherium*, *Anisodon*, &c. Among others, a vast quantity of Mastodon remains have been met with, including the whole dentition, from the young sucking-calf up to the adult and old animals. A superb skeleton was disinterred by Laurillard at Seissan, so complete in every respect, that it has been set up in the Paris Museum, alongside of the skeletons of the existing Indian and African Elephants. Two points, which have been invariably exhibited by all these teeth, are of special importance in their bearing upon the present question: the first is, that the intermediate molars are constantly three-ridged, or, in other words, belong to the *Trilophodon* type—no *Tetralophodon* molars having ever, within the knowledge of M. Lartet, been discovered, either at Simorre, Sansan, or Lombez; the second is, that they entirely agree with the original Simorre types described by Cuvier, upon which his *M. angustidens* is founded, and that they are absolutely the narrowest of all known Mastodon molars. Another remarkable character of the species is this—that, in harmony with the narrow teeth, the horizontal ramus of the lower jaw is more compressed, and higher in relation to the width, than in any other known Mastodon. This is well shown in the Paris skeleton, and in numerous lower

[1] Dictionnaire Universel d'Histoire Naturelle, tom. viii. p. 29.

[2] Fauna Antiqua Sivalensis, par. i. (1846), p. 57. (See vol. i. p. 90.—Ed.)

Fig 4

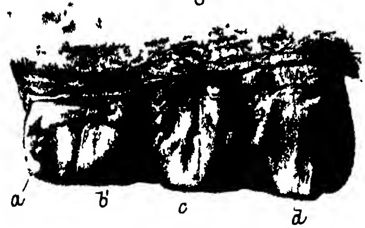


Fig 1

Fig 3

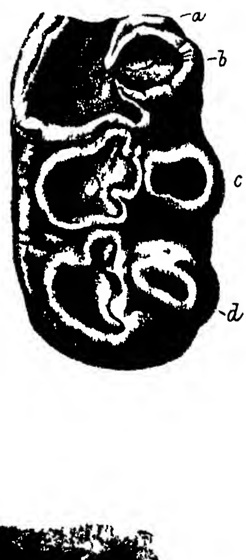
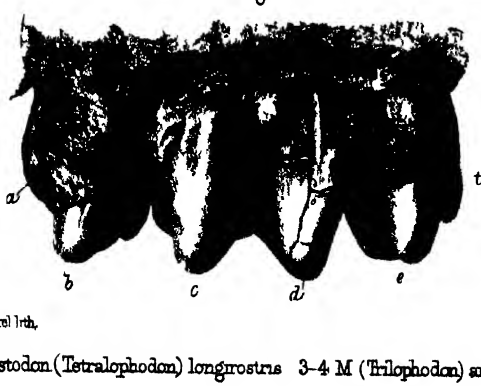


Fig 2



G.H.Ford del. J Dinkel lith.

W West imp

1-2 Mastodon (Tetralophodon) longirostris 3-4 M (Trilophodon) angustidens

jaws contained in the palæontological gallery. M. Lartet possesses, in his rich collection at Seissan, several lower jaws exhibiting the same character. A nearly entire skeleton of this species was discovered, in the latter part of 1855, in the sandstone-quarry of Veltheim, near Winterthur, in Canton Zurich; this I was enabled to examine minutely through the kindness of M. Ziegler-Ernst of Winterthur. It is the largest specimen of the species that I have anywhere seen. The lower jaw, although in fragments, is nearly complete, and shows the extreme compression of the horizontal ramus, and its great depth. I found, by measurement with the callipers, that this compression was even greater than is seen in *Dinotherium*, while the lower jaws of most of the known Mastodons and Elephants yield more or less of a circular section.[1] This tenuity of form is carried on throughout the skeleton in the Mastodon of Simorre.

From these remarks it would appear sufficiently evident that, whether we are guided by priority of description and reference to the original specimens, or by the obvious signification of the term, the title of *Mastodon angustidens* is legitimately applicable to the *Trilophodon* of Simorre, and to no other species; for it is, *par excellence*, the 'Mastodonte à dents étroites' of Cuvier. The species, thus limited, has nowhere been met with in the fossil state in England.

Mastodon Arvernensis and M. longirostris.—Cuvier, as already stated, included under the name of *M. angustidens* other remains which do not belong to it. Upon this head nearly all the French palæontologists are agreed, although at variance as to the details. Of the specimens figured in the four plates devoted to 'Divers Mastodontes' in the 'Ossemens Fossiles,' all those from South America, amounting to 10 in number, are by common consent referred to one or two species peculiar to that country. Seven are referable to the Mastodon of Simorre with narrow molars; one to *M. Tapiroïdes*; five are doubtful, either from inexact knowledge as to their origin, or from their undecided characters; and all the rest, being eleven in the aggregate, are from Italy, with the exception of one specimen from Trevoux in France. It is curious to observe the different views that have been taken of them. De Blainville[2] limits the South American remains to a single species, while Laurillard and Gervais range them under two well-defined forms. De Blainville and Owen agree with Cuvier in referring the so-called narrow-toothed remains from Simorre, Italy, Auvergne, and Eppelsheim also, to a single species. Laurillard, devoted as he was

[1] See Appendix, p. 73. – [Ed.]

[2] Ostéographie: Des Éléphants.

to the traditions of his great leader, was compelled by the evidence to admit two species—namely, *M. angustidens*, under which title he included the Italian, Auvergne, and part of the Eppelsheim remains; and *M. longirostris*, under which he ranged both the principal part of Kaup's Eppelsheim species, and the whole of the Simorre remains.[1] Misled by the undue importance which he attached to the presence of mandibular incisors common to the two forms, he sunk the characters presented by the molars, and confounded ternary-ridged and quaternary-ridged forms under the same name, although it is distinctly evident that he was aware that two of the European species severally possessed 3 and 4 ridges to their intermediate molars, and that the ternary formula was common to the Mastodons of North America and of Simorre. In 1828, four years before the demise of Cuvier, Croizet and Jobert[2] proposed the name of *M. Arvernensis* for the Auvergne remains, as distinct from *M. angustidens*; and soon afterwards Dr. Kaup[3] published his magnificent series of the Eppelsheim form as equally distinct, under the designation of *M. longirostris*, which has been regarded by Hermann von Meyer to be identical with *M. Arvernensis*.[4] Lartet[5] had accurately determined the milk and permanent dentition (so far as the true molars are concerned) of the Simorre form as far back as 1847. He assigned three ridges to the last milk molar and to the antepenultimate and penultimate true molars in both jaws; and in his 'Notice,'[6] published in 1851, he proposes to distinguish it by the name of *Mastodon Simorrense*, retaining the designation of *Mastodon angustidens* for the Italian and Auvergne remains, characterized by four ridges in the penultimate true molar, instead of three. Lartet at the same time[7] proposed the name of *Mastodon Gaujaci* for a supposed small form from the same Miocene deposit at Lombez. Laurillard considered it as furnishing a confirmation of the conjectural species named *Mastodon minutus* by Cuvier.[8]

Gervais followed Laurillard in considering the Simorre *M.* (*Triloph.*) *angustidens* and *M.* (*Tetraloph.*) *longirostris* as belonging to the same species, *M. longirostris*; but adopted for the Auvergne form the name of *M. Arvernensis*; and went a step beyond his predecessors in proposing a new name for the Mastodon remains found in the arenaceous deposits near

[1] Dictionnaire Universel d'Histoire Naturelle, tom. viii. p. 29.

[2] Recherches sur les Ossemens Fossiles du Département du Puy-de-Dôme, p. 133.

[3] Ossemens Fossiles de Darmstadt, pt. iv.

[4] Nova Acta Acad. Nat. Cur. vol. xvii. p. 113.

[5] Dictionnaire Universel d'Histoire Naturelle, tom. viii. p. 29.

[6] Notice sur la Colline de Sansan, p. 24.

[7] *Op. cit.* p. 27.

[8] Dictionnaire Universel d' Histoire Naturelle, tom. viii. p. 31.

Montpellier, which he identifies with the Mastodon of the Astesan and the Val d'Arno under the name of *M. brevirostre*.[1] Pomel, in his memoir of 1848, proposes a new name for the Simorre *Trilophodon*, namely *M. Cuvieri*, and he retains that of *M. angustidens* for the Auvergne and Italian forms, admitting their distinctness from the *M. longirostris* of Eppelsheim.[2] In his 'Catalogue Méthodique' of 1854, he adopts the name of *M. Arvernensis* for the Auvergne and Montpellier form, to which he assigns the additional foreign localities of the Val d'Arno, Piedmont, and the Crag in England; but in a remark on the next page, he reiterates the view expressed in his previous memoir, that he has retained the name of *M. angustidens* for the species of Italy.[3] Nesti,[4] in his description of the Tuscan remains, adopts the name of *M. angustidens* (Mastodonte a denti stretti) in the loose comprehensive sense in which it was used by Cuvier; while Eugenio Sismonda, aware of the various and contradictory opinions upon the point, guardedly described the fine skeleton found at Dusino, in Piedmont, under the title of 'Osteographia di un Mastodonte angustidente.'[5] My friend and collaborateur, Colonel Sir Proby Cautley, in 1836, figured and described some teeth of the Indian species, to which we subsequently restricted the name of *M.* (*Tetralophodon*) *Sivalensis*, as identical with the 'Mastodonte à dents étroites' of Cuvier; and he expressed at the same time the opinion, that the Italian form (which he had more particularly in view) would, with the Sewalik one, constitute a subgenus of the *Angustidens* type, in contradistinction to the type of Clift's *M. latidens*.[6]

These, so far as I am aware, are the leading opinions which have been put forward by original writers on this much-disputed question. Those which have been expressed by the compilers of systematic works on Palæontology, however useful, are of little weight in the discussion, as they express more the balance of the authorities numerically, than opinions formed upon independent examination of the subject by themselves. The specific name *Mastodon angustidens* is even struck out of the list of European species, except as a synonym, in the last edition of Bronn's 'Lethæa,' and replaced by the terms *M. Arvernensis*, *M. longirostris*, and *M. Cuvieri*.[7] Palæontologists would confer a great boon on Geology, if they could be brought to agree in applying this

[1] Annales des Sciences Naturelles, 3me série, tom. v. p. 268.

[2] Bull. de la Soc. Géologique, (1848), tom. v. p 257.

[3] Catal. méthod. et descript. pp. 74, 75.

[4] Nuovo Giorn. di Letterat. (Pisa), tom xii. pp. 17–34.

[5] Mem. del Reale Accad. di Torino (1851, pp. 175–235.

[6] Journ. of the Asiat. Soc. of Bengal, vol. v. p. 294. (See vol. i. p. 126.—Ed.)

[7] Lethæa Geognostica, 3rd edit. vol. iii. pp. 827–832 (1856).

name (*M. angustidens*) to the Simorre form, for which it was devised by Cuvier.

The views which we entertain were partially disclosed in the first part of the letter-press of the 'Fauna Antiqua Sivalensis,' and fully elucidated in the four plates of outline heads (from Plate XLII. to Plate XLV. of Part 5 of the Illustrations),[1] where a synopsis is given of all the species, fossil and recent, then known. The forms included under the nominal species of *M. angustidens* of Cuvier are there ranged as distinct species, namely:

M. (Triloph.) angustidens.
M. (Triloph.) Andium.
M. (Tetraloph.) longirostris.
M. (Tetraloph.) Arvernensis.

The only change which subsequent investigation on fresh materials has led us to make, is to transfer *M. Andium* from the subgenus *Trilophodon* into that of *Tetralophodon*, for reasons which it is not necessary to detail on the present occasion.[2] Of these forms, the only one which I believe has been met with in the fossil state in England is *M.* (*Tetralophodon*) *Arvernensis* (Plate IV.); and I shall now proceed to the consideration of the evidence in support of this conclusion.

British specimens of Mastodon.—Remains of two out of the three species of *Mastodon* with which we are chiefly concerned now—viz., *M.* (*Trilophodon*) *angustidens*, *M.* (*Tetralophodon*) *longirostris*, and *M.* (*Tetralophodon*) *Arvernensis*—have been discovered on the Continent, in the localities where they prevail, in such a perfect condition, that very little remains to be desired in regard to their entire osteology. The skeleton of *M.* (*Trilophodon*) *angustidens* from Seissan, set up in the Gallery of Comparative Anatomy in Paris, is so complete in every respect, from the cranium down to the digital phalanges, that it may be compared, bone for bone, throughout the frame, with the skeletons of the African and Indian Elephants which adjoin it. Of *M.* (*Tetraloph.*) *Arvernensis*, a nearly entire skeleton was disclosed by a railway excavation at Dusino, near Asti in Piedmont, and is now deposited in the Turin Museum. It is deficient only in the cranial portion of the head, right hind-leg, part of the scapula and pelvis, and some of the bones of the carpus and tarsus. The upper and lower jaws, with the tusks entire to their tips, are preserved; and Prof. Sismonda was only deterred by the brittle condition of the bones from attempting to reconstruct the whole. A skeleton of the same species, nearly as perfect, which I have examined, was discovered in the lower Val

[1] See Plates I. & II of this volume, and page 176 of vol. i. [Ed.]

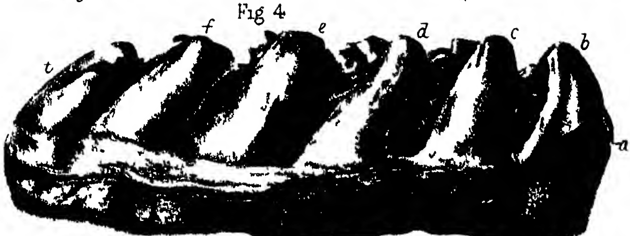
[2] See Note 3 to Synoptical Table.—[Ed.]

Fig 1

Fig 2

Fig 3

Fig 4



G.H. Ford del J Dinkel lith W West imp

Mastodon (Tetralophodon) Arvernensis, from the Crag

d'Arno in a marine stratum, along with the skeleton of a Whale. It is now laid out in the Museum at Florence, together with numerous other bones of the same species. From the Miocene sands of Eppelsheim, Kaup disinterred the upper and lower jaws, with an immense quantity of molars, showing the entire dental series, milk and adult, besides various other portions of the skeleton, of *M.* (*Tetralophodon*) *longirostris.* The materials are therefore so abundant now, that it is in a measure easy to institute a comparison, more or less rigorous, between the three species.

But as regards the English remains of Mastodon, it is quite the reverse. Only solitary teeth detached from the jaws, or part of a mutilated young cranium, have hitherto been described, and the teeth in most cases are mutilated. The beautiful vignette which heads the chapter upon *Mastodon angustidens* in the 'British Fossil Mammalia' would convey a very exaggerated notion of the English remains as they are ordinarily met with, but that the author takes care to apprize his readers that it is derived from Kaup's figure of the Eppelsheim species. No good specimen of the lower jaw, so far as I am aware, has yet been found in Britain; nor have any of the large bones of the extremities been identified, although it is more than probable that such do exist in the numerous collections which have been formed in Norfolk and Suffolk. The pieces are usually more or less mutilated; and it is clear that the bones have been broken up before the fragments were deposited in the strata where they are now found. Nothing approaching the remains of a perfect skeleton has been seen in any one locality, with the exception of the notable case recorded by the Rev. J. Layton, in which the entire skeleton of a Mastodon is stated to have been found lying on its side, stretched out between the chalk and gravel, at Horstead near Norwich, on a bed of marl. The bones in this instance were heedlessly broken up by the workmen, or dispersed before any steps could be taken for their preservation.[1]

The molars or other fragments occur scattered and detached. Prof. Owen mentions a well-preserved atlas of (apparently) *Mastodon angustidens* as being preserved in the Ipswich Museum.[2] Mastodon molars have been found both in the Red Crag of Suffolk and in the Fluvio-marine Crag of Norfolk and Suffolk; in the former at Sutton and Felixstow—in the latter at Postwick, Whitlingham, Thorpe, Horstead, and Bramerton near Norwich, and at Easton near Southwold. Mr. Charlesworth, in reference to their supposed raity.

[1] Fairholme's 'Geology of the Scriptures,' p. 281.

[2] Quart. Journ. Geol. Soc. vol. xii. p. 223.

mentions that, within the twelve months preceding September 1851, upwards of a dozen of Mastodon molars had been discovered, in washing the Crag to get out the phosphatic nodules.[1] Prof. Owen notices their occurrence in the Crag-pits of Suffolk.[2] I am not aware that they have yet been discovered in the Fluvio-marine Crag of Bridlington in Yorkshire, nor in any of the freshwater deposits below the Drift, where remains of Elephant and Hippopotamus are more or less abundant.

It is no part of the object of this communication to describe the numerous remains of Mastodon from the Crag, that are to be met with in different English collections. All that is intended is to determine what the species really is, and only such characteristic specimens will be referred to as exist either in original or as casts, in public museums, or as have been so accurately figured and described in works of authority as to be susceptible of satisfactory identification.

First, as regards the *Molars*.—The most perfect specimen that has yet been discovered, is the famous Whitlingham tooth, which forms the frontispiece of Mr. W. Smith's 'Strata Identified,' and of which (reversed) a beautiful woodcut is given in fig. 97 of the 'British Fossil Mammalia.' It is also very carefully represented, unreversed, both as regards the plan and profile views of the crown, in the 'Fauna Antiqua Sivalensis' (Plate XXXVI. figs. 8 and 8 *a*).[3] It is the last true molar (upper jaw, right side), being composed of five ridges, with an anterior 'talon,' and a strong back 'talon.' The crown is obscurely divided, longitudinally, by a shallow cleft along its axis. Each ridge consists of about two pairs of thick, high, conical mammillæ, with very thick enamel. Deep clefts or valleys intervene between these ridges; but the valleys, instead of being transverse, are interrupted in the middle by one or more large accessory conical mammillæ, which are interposed between the ridges, and alternate with the outer and inner divisions. These mammillæ are usually connected with the inner division of each ridge in the upper jaw, and with the outer division in the lower. They are much thicker than in the other species of Mastodon which possess them, and have a large conical core of ivory. The consequence of this complex composition of the crown is that, when the ridges have been worn down by continued grinding, they present a great number of distinct *alternate* trefoil discs, surrounded by a ring or belt of enamel, instead of the single or double transverse disc exhibited by the Mastodon of Eppelsheim, *M.* (*Tetralophodon*) *longirostris*, or by the *M.* (*Trilophodon*)

[1] Warren, 'On *Mastodon giganteus*,' 2nd edit. p. 201.
[2] *Op. cit.* p. 223.
[3] See vol. I. p. 468.—[ED.]

angustidens of Simorre. In the Eppelsheim species, of which I have carefully examined all the molars contained in the rich collection at Darmstadt, there is a considerable range of variety, as regards the accessory tubercles which flank the main ridges. In some of the last molars, the main ridges are perfectly free from any outlying or flanking mammillæ; they are regularly transverse, and the valleys between are equally transverse, and open throughout. In others, the ridges bear numerous small warty tubercles of enamel, which jut into the valleys and distort them. But the transverse continuity of the valleys is never blocked up by the large conical mastoid mammillæ, which in the molars of *M.* (*Tetralophodon*) *Arvernensis* invariably alternate with the main ridges, and reduce the valleys to disconnected gorges, occupying the outer and inner sides of the crown. The accessory tubercles in the Eppelsheim species are so unimportant, that their only effect, after advanced wear, is to expand the diameter of the disc, or communicate to it something of a trefoil pattern. The discs are always transverse, while in the English Crag Mastodon they are invariably more or less alternate. In illustration of this very obvious differential character in *M.* (*Tetralophodon*) *longirostris*, the beautiful series of figures given by Kaup in the 'Ossemens Fossiles de Darmstadt,' from Plates XVI. to XXI. inclusive, may be quoted; but I would more especially refer to figs. 4 and 5 of Pl. XVI., figs 1, 3, 4, and 9 of Pl. XVIII., and figs, 2, 6, and 7 of Pl. XXI.

We have endeavoured to exhibit these differences in a well-marked and obvious manner, by contrasted figures (drawn with the greatest care and fidelity by Mr. George Ford) of the same tooth in three species, placed side by side, in Plate XXXVI. of the 'Fauna Antiqua Sivalensis.' Figs. 6 and 6 *a*[1] represent in plan and profile the last molar (upper jaw, left side) of *M.* (*Tetralophodon*) *Sivalensis*, an Indian fossil species, which is the most nearly allied to the English Crag Mastodon, so far as the alternate disposition of the crown-mammillæ is concerned, but differing in the ridge-formula. Figs. 8 and 9 represent two specimens of the same tooth of *M.* (*Tetralophodon*) *Arvernensis*, the one being Mr. William Smith's Whitlingham fossil, and the other (fig. 9) Captain Alexander's specimen, dredged up between Southwold and Easton, of which there is a cast in the Geological Society's Museum. Figs. 12 and 13 represent two specimens, of different races or sexes, of the same tooth of *M.* (*Tetralophodon*) *longirostris*, from Eppelsheim. The Sewalik molar (fig. 6) exhibits six ridges and a hind 'talon;' the Crag and Eppelsheim molars

[1] See vol. i. Plate ix. figs. 1 and 2.—[Ed.]

show only five ridges and the 'talon.' In the Eppelsheim teeth (figs. 12 and 13), the crown is broad; the mammillæ are thicker in proportion to their height; the ridges are less elevated, and consist of a greater number of coronal points (there being often as many as six or seven to each ridge); the outer and inner lines of points converge less towards the apex of the crown as they rise upwards; and the valleys are either entirely open and transverse, or interrupted only by an insignificant amount of warty tubercles. In the Crag fossils (figs. 8 and 9), the crown is narrower in proportion; the mammillæ form more attenuated cones, and are more elevated; the ridges consist of fewer coronal points, which, instead of running across in a wide crest, appear, so to speak, as if they had been squeezed together, and their transversality disturbed; the outer and inner lines of points, especially the latter, converge rapidly as they ascend, rendering the apex of the crown much narrower than the base; the outer and inner divisions of the crown are more or less alternate, and the vallicular mammillæ that flank and alternate with them are large conical points, which yield discs of wear approaching in size to those of the principal points; the valleys are completely obstructed by these mammillæ, and reduced to a gorge on either side of them. When the teeth are viewed in profile (such as fig. 8, on the above-mentioned plate, compared with fig. 13), the difference is very marked, the latter yielding a series of salient and re-entering angles, corresponding with the prominent points and valleys, which the former does not, the re-entering angles being intercepted by a dark shade, which represents the accessory mammillæ. If the eye is next directed to figs. 6 and 6 *a*, the differences are stlll more marked, *M.* (*Tetralophodon*) *Sivalensis* exhibiting a greater amount of alternation of the crown-mammillæ, and more complexity of pattern, than is even seen in the English Crag Mastodon. To summarize the distinctive characters of the two European species, it may be stated, that *M.* (*Tet.*) *Arvernensis* (Pl. IV.), with *M.* (*Tet.*) *Sivalensis*, resembles the Hippopotamoid type, and that *M.* (*Tet.*) *longirostris* (Plate III. fig. 1), with the Indian species of *M.* (*Tet.*) *latidens*, the Dinotherian type, in so far as the form of the crowns of the molar teeth are concerned.[1]

[1] In opposition to this view, Kaup has lately endeavoured to show that his own species, *Mastodon longirostris*, is merely the adult form of *M. Arvernensis* (Beitrage, genus Mastodon, 1857). Herr Ed. Suess, however, of the Imperial Museum of Mineralogy of Vienna, thus writes, in a letter to Mr. Rupert Jones, respecting Dr. Falconer's view:—'I agree wholly with Dr. Falconer in distinguishing the Italian Tetralophodon from the *Mast. longirostris* of Eppelsheim, and believe this latter one to be quite as good a species, although the author (Kaup) himself has thought good to cancel this species and to unite both the Tetralophodons of Europe into one species in his last book.'—[ED.]

Of the last true molar of the lower jaw, no good entire specimen, so far as I am aware, has yet been published as having been yielded by the English Crag. But in the Museum of the Geological Society, there is a cast of a very fine specimen of this tooth from the left side of the lower jaw, which, according to the label on the cast, was found in the Crag of Suffolk (see Pl. IV. figs. 3, 4). It is a nearly unworn germ, measuring about 8½ inches long, by 3 inches in width in front, without fangs, and the anterior ridge alone being slightly touched by wear. It is composed of five ridges and a talon of two mammillæ. The anterior ridge shows two pairs of mammillæ; the next four ridges present only two large conical mammillæ each, which converge rapidly towards the summit of the crown, and are disposed in an alternate manner. One or more large accessory mammillæ are interposed between the ridges, blocking up valleys in the manner described as characteristic of the species, and the ridges are inclined with a slope, which increases successively backwards. The talon appears to have been composed of a pair of points, one of which is mutilated on the inner side, and a small portion of the back end of the tooth is wanting. The slope of the posterior ridges is so pronounced as to approach nearly to the character of 'imbrication.' In this respect the specimen closely resembles the Val d'Arno molar figured by Cuvier (Divers Mastodontes, Pl. IV. fig. 7), which he describes as the last of the upper jaw;[1] but it would seem, from the form and contour, to be an entire germ of the last inferior molar, and, in our opinion, of the same species as the Crag Mastodon, namely, *M.* (*Tetraloph.*) *Arvernensis.*

A fragment composing the posterior half of the last inferior true molar has been noticed and figured by Mr. S. Woodward.[2] It is composed of seven prominent conical mammillæ, disposed in three ridges, which contract very much behind, and terminate in an odd talon-tubercle. These tubercles form two lines, an outer and an inner, and they are placed in regular alternation with each other. A corresponding fragment, of which there is a cast in the Geological Society's Museum, is represented by Pl. XXXVII. figs. 9 & 9*a* of the 'Fauna Antiqua Sivalensis.' The mammillæ, in this case also, form two alternate rows, each ridge being composed of a pair of points.[3]

The finest detached specimen of the Crag species that I have anywhere seen is a last lower molar, left side, found below the citadel of Montpellier, and which has been figured

[1] Oss Foss 4to edit tom i p. 258.
[2] Mag. of Nat. Hist (1836), vol. ix. p. 152, fig. 22.
[3] See vol. i. p. 470.—[Ed]

and described by Gervais.[1] Casts of this piece are to be met with in many of the principal European Museums. It is of large size, being about 9½ inches long by 3¼ inches wide at its anterior end, and it consists of five principal ridges and a double talon. The five anterior ridges are well worn, and exhibit the characteristic alternation of the discs in a very prominent manner, nothing approaching which has ever been seen in an Eppelsheim specimen. M. Gervais refers this tooth to his *Mastodon brevirostre*, as distinguished from *Mastodon Arvernensis*; but the grounds upon which he has attempted this separation are wholly insufficient.

The same peculiar characters in the alternate disposition of the mammillæ of the crown are finely exhibited in the last lower molar of the nearly allied Indian *M.* (*Tetraloph.*) *Sivalensis*, as represented in Pl. XXXVII. figs 8 & 8 *a* of the 'Fauna Antiqua.'[2] The specimens resemble each other so closely, that my colleague Sir Proby Cautley,[3] in his earliest description, considered them to be identical species.

If, on the other hand, we examine the equivalent teeth in the lower jaw of *M.* (*Tetralophodon*) *longirostris* of Eppelsheim, the same differences as occur in the upper molars are constantly presented. The ridges are transverse, and the coronal eminences in a greater number than a pair of mammillæ, which latter, on the outer and inner sides, are opposed, and not alternate. Figs. 1, 2, & 3 of Pl. XIX. of Kaup's 'Ossemens Fossiles' furnish excellent illustrations.

When these molars, upper and lower, are ground down by well-advanced use, the alternation of the discs in the one species, and their transversality in the other, become still more conspicuous. The former character is exhibited in a very marked manner by figs. 1, 3, & 6 of Pl. IV. of Cuvier's 'Divers Mastodontes,' above referred to. All the specimens are of Italian origin, being either from the Val d'Arno or from the plains of Lombardy and Liguria. Cuvier remarks upon one of them (fig. 6), that it is 'remarquable par des festons plus nombreux que dans les autres.'[4] They are all referable to *M.* (*Tetralophodon*) *Arvernensis*. The alternate disposition of the discs of wear is also seen well in the specimens of *M.* (*Tetraloph.*) *Arvernensis* discovered in the Astesan near Dusino, and figured and described by Sismonda;[5] while the transverse discs of the Eppelsheim species are more or less apparent throughout Kaup's Illustrations, and

[1] Annales des Sciences Naturelles, 3me sér. tom. v. p. 268, and Paléontol. Française, p. 38, tab. iii fig. 7.

[2] See vol i. p. 470.—[Ed.]

[3] Journal Asiatic Society of Bengal, vol. v. p. 294. (See vol. i. p. 126.—Ed.)

[4] Oss. Fossiles, 4to edit. tom. i. p. 259.

[5] Osteograph di un Mastodonte angustidente, tab 1, figs. 2 and 3 (Mem. R. Accad. Sc. Torino. sér. 2, vol xii.).

more especially in figs. 4 & 5 of Pl. XVI., figs. 1, 2, 3, & 5 of Pl. XIX., and figs. 2 & 6 of Pl. XXI. of his work above quoted.

Of the other true molars, *i.e.* the antepenultimate and penultimate, various specimens, more or less perfect, have been yielded by the Crag. Several existed in Mr. Robert Fitch's interesting collection at Norwich when I examined it in 1846, and probably a considerable addition has been made to it since. Two of these are figured in the 'British Fossil Mammalia' (pp. 280, 281). Fig. 98 is described by Professor Owen as the penultimate upper. The anterior portion is broken off; what remains of the crown shows four ridges and a talon. But for the position assigned to it by so able and practised a palæontologist, the figure would convey the impression of its being a lower instead of an upper molar, from the narrowness of the crown in comparison with the width, and from the form of the hind talon. Fig. 99 represents a corresponding penultimate lower molar, also from Mr. Fitch's collection. Both teeth—the one of which has the crown represented in plan, the other in profile—show in a strongly marked manner the characteristic alternation of the mammillæ, which is never seen in the corresponding molars of the Eppelsheim species. Moreover, the mammillæ are more elevated, their conical isolation more defined, and the enamel layer thicker than in *M.* (*Tetraloph.*) *longirostris*. There is a peculiar wavy and finely grooved rugosity of surface, which is seen on the enamel near the basis of the crown and 'bourrelet' where it exists in the molars of the Crag Mastodon (see Pl. IV. fig. 4), and of the nearly allied Indian species *M.* (*Tetralophodon*) *Sivalensis*. It may be compared to the appearance yielded by a bound book when the edges of the leaves slightly overlap, and they are bent in a flexuous curve. This peculiar rugosity is not nearly so conspicuous in the Eppelsheim species, nor in the *M.* (*Trilophodon*) *angustidens* of Simorre.

The finest English specimen of one of the 'intermediate molars' of the Crag Mastodon that has come under my observation is a germ of the penultimate true molar (upper jaw, right side), lately discovered by the Rev. Mr. Marsden in the bed of coprolitic or phosphatic nodules in the parish of Ramsey in Essex, about three miles west of Harwich, and kindly lent to me for description. It is represented (about two-ninths of the natural size) by figs. 1 & 2, Pl. IV. of the accompanying illustrations. It consists of the shell of the crown quite entire, the nucleus of the ivory core not having become fully calcified, nor any of the fangs developed. The crown presents four intact ridges, with a front and a back talon. The mammillæ of the outer and inner lines are very high, and converge as they ascend, so that the apex of the crown is

much narrower than the base. Two large outlying mammillæ are interposed between the first and second ridges, one between the second and third, and one between the third and fourth. A large tubercle, flanking the inner division of the first ridge, forms the commencement of the anterior talon. The posterior talon consists of a line of about six low tubercles. The intermediate flanking mammillæ, as is usual in the species, interrupt the transverse continuity of the valleys, which are reduced to an outer and inner gorge. It is manifest that, if the crown were ground down by wear, the disposition of the tubercles is such that a series of trefoil discs, more or less alternate, would be the result. The dimensions of this specimen are—length 4·9 inches, width of crown in front 2·6 inches, width at the last ridge 2·9 inches.

Premolars.—That vertically successional teeth replace one or more of the milk molars in *M.* (*Tetraloph.*) *Arvernensis* has been proved by the original specimens from Auvergne, upon which the species was founded by Croizet and Jobert. Fig. 7 of Pl. XI. of their work [1] exhibits an upper jaw of a very young animal, containing the antepenultimate and penultimate milk molars *in situ*, the former consisting of two pairs of points, disposed in two ridges, the latter showing three ridges. Behind the second tooth there is introduced, in the figure above referred to, a germ-fragment consisting of two ridges (marked A), as if of the third milk molar; but Abbé Croizet states, in the descriptive details, that the fragment was found detached, and that for various reasons, which are detailed, he considers it to be incorrectly placed in the figure. In the original specimen, which I had an opportunity of examining at Paris, the remains of part of the alveolus of a vertical premolar were distinctly visible above the penultimate milk molar; and M. Laurillard informed me that he had seen the germ of this premolar, the tooth 'A' above referred to being the one in question, *i.e.* the penultimate premolar. The last premolar, which is the vertical successor of the last milk molar, has not as yet been observed *in situ*, so far as I have had the means of ascertaining.

No premolars of the Crag Mastodon, from English localities, have either been figured or described in the 'British Fossil Mammalia,' or elsewhere, up to the present time.[2] This is of little moment, in so far as the mere identification of the species is concerned. Premolar specimens may probably be found either in Mr. Fitch's or in some other of the Norfolk collections.

[1] Oss. Fossiles du Départ. du Puy-de-Dôme, pp. 134, 135.

[2] The specimen referred to by Mr. Fitch, as cited in the 'British Fossil Mammalia,' p. 290, is not a premolar of the Crag Mastodon.

Milk molars.—Of the milk series it is not necessary on the present occasion to enter on many details. I will refer only to one or two characteristic specimens. The most perfect and instructive yet met with was discovered in the Crag at Postwick by Mr. Wigham, to whom I was indebted for the means of comparing it carefully with a corresponding specimen of *M.* (*Tetraloph.*) *longirostris* from Eppelsheim, belonging to the Earl of Enniskillen. It consists of the left upper jaw of a calf Crag Mastodon, with the last milk molar beautifully preserved *in situ*, and the remains of the empty alveolus of the penultimate milk molar in front of it. The tooth is stated, in Sir Charles Lyell's memoir on the 'Relative Ages of the Tertiary Deposits of Norfolk,'[1] to be the 'second true molar.' But it is really the last milk molar. He adds:—'This fragment was sufficiently perfect to enable Mr. Owen, to whom I submitted it, to refer it to *Mastodon longirostris*, a species also found at Eppelsheim.' The crown measures 3 inches long by 1·8 inch broad, and is composed of four ridges, with a front and hind talon, and a well-pronounced basal 'bourrelet.' The three anterior ridges are more or less worn, especially along the inner division; the last ridge is nearly intact. Two views of this tooth, drawn with the utmost care by an artist of well-known power and fidelity, Mr. George Ford, are shown in the 'Fauna Antiqua Sivalensis,' Pl. XXXVI. figs. 7 & 7 *a*.[2] The ridges are seen to be connected by one or two stout conical mammillæ, which occupy the middle of the valleys, interrupting their transverse continuity, and alternating with the divisions of the main ridges, in the manner characteristic of the older or true molars previously described. If these figures are compared with Pl. XL. figs. 6 & 6 *a*[3] of the same work, by the same artist, which represent Lord Enniskillen's very beautiful specimen of the young calf Mastodon from Eppelsheim, the distinctive characters of the two species will be found to be carried on throughout. The Eppelsheim specimen is a little younger than the Crag fragment; it shows the series of three milk molars *in situ*. The third milk molar is nearly intact; the four ridges of which it is composed are seen to be transverse, compressed, and composed of a number of little points; the valleys are open, with the exception of a tubercle in the first, and two or three minute tubercles in the last valley, which nowise intercept their transverse continuity. The back talon forms a low transverse free ridgelet, as in *M.* (*Tetralophodon*) *latidens* of India; while in *M.* (*Tetralophodon*) *Arvernensis* the talon tubercles are huddled together and accrete to the last ridge.

[1] Mag. of Nat Hist. (1839), p. 318.
[2] See vol. i. p. 467.—[Ed.]
[3] See vol. i. p. 472.—[Ed.]

Sir Charles Lyell, in his 'Manual,'[1] gives a figure of Mr. Wigham's tooth of the natural size, in which a very notable character of the young molars is well brought out. The enamel of the mammillæ is seen to be furrowed vertically by numerous deep parallel grooves, presenting the appearance of a reeded column or of a number of cords pressed close together, and disposed around a thick central axis. The shell of enamel shows as if it were composed of distinct narrow pieces glued together. The same character is attempted to be represented by *b* & *c* of fig. 7, Pl. XXXVI. of the 'Fauna Antiqua Sivalensis,' also of the natural size. It does not occur in the corresponding young molars of *M.* (*Tetralophodon*) *longirostris*. The enamel-surface in these is superficially wrinkled and furrowed with numerous irregularities, without however exhibiting the symmetrical fluting observable in the Crag Mastodon. So conspicuous is this character, that I believe that the young teeth of the two species could be distinguished from each other by portions of their enamel alone, occurring mixed in a collection. I would refer to a figure given by Kaup of the dentition of a young *Mastodon longirostris* in Pl. XVI. fig. 1 of his 'Ossemens Fossiles,' for the comparison. It is of the natural size, and the last milk molar may be contrasted with the corresponding tooth of the Crag species figured by Sir Charles Lyell. It was this character in the young teeth which chiefly led Croizet and Jobert,[2] in 1828, to propose *Mastodon Arvernensis* as a distinct species. They met with specimens in Auvergne, mostly of very young animals, of both the upper and lower jaws, in which the last milk molar was unworn; and they were struck with the remarkable complexity of the crown-ridges, composed of a great number of small wart-like cones, separated by the decurrent vertical grooves, which we have referred to. But the indicated character was not accepted by Cuvier as of sufficient importance to distinguish the species from his too comprehensive *Mastodon angustidens*.

Another fine specimen of the last upper milk molar, from Mr. Fitch's collection, is figured in the 'British Fossil Mammalia' (fig. 100, p. 284). Like Mr. Wigham's specimen, the crown is composed of four ridges and a talon, with the same complexity of pattern, alternation of the flanking tubercles, and interruption of the valleys. It is only necessary to cite it here, as proving the constancy of the characters of the Crag specimens. Prof. Owen describes this tooth as the 'fourth upper molar;' while he assigns a different position and value to Mr. Wigham's specimen, considering the latter

[1] Manual of Element. Geol 5th edit. (1855), p. 166 fig. 133.

[2] Croizet et Jobert, Oss Foss. du Départ du Puy de-Dôme (1828), p. 133.

to be the 'second true molar.' In our view they are both last milk molars, which would be the equivalent of what Prof. Owen designates as 'the fourth in the order of size, and the third in the order of position, counting backwards in the upper jaw, before any of the teeth are shed.'[1]

There is some intricacy in the terms expressive of the numerical values which Prof. Owen assigns to the different molars of Mastodon in his descriptions, both in the 'British Fossil Mammalia' and in the 'Odontography.' This, I believe, has arisen from the peculiar views there advanced as to the order of succession of the premolar teeth in this genus; and as it is a point of systematic and palæontological importance in reference to the disputed affinities between *Mastodon* and *Dinotherium*, I think it desirable to make a few remarks on the subject. In both the works here cited,[2] it is affirmed that Mastodon is distinguished from Elephant, in a well-marked and unequivocal manner, by two dental characters: the first is the presence of tusks in the lower jaw; the second 'is the displacement of the first and second molars' (meaning milk molars) 'in the vertical direction by a tooth of simpler form than the second, a true *dent de remplacement*, developed above the deciduous teeth in the upper, and below them in the under jaw.' Prof. Owen, in his remarks upon Mr. Fitch's specimen of the last milk molar (fig. 100), goes on to say, 'In Dr. Kaup's figure the tooth in question' (*i.e.* the third) 'is associated with the first and second molars of the *Mastodon angustidens*, which are much worn, and are true deciduous teeth—the only ones, in fact, which strictly correspond with the deciduous teeth of ordinary Pachyderms.'[3] In this view, when the antepenultimate and penultimate milk molars are shed, and the penultimate premolar has made its appearance, he designates the latter as the 'third molar tooth;' and the last milk molar, which is behind it in position, but anterior in appearance, he calls the 'fourth molar tooth,' although fully aware that there were good grounds for regarding it 'as the last of the theoretically deciduous series, although it has no vertical successor.' But this conclusion as to the absence of a vertical successor to the tooth in question was premature. I detected both the penultimate and last premolars *in situ* in the jaws of *E. (Loxodon) planifrons*, a Sewalik fossil Elephant, upwards of twelve years ago. The evidence is published in the 'Fauna Antiqua Sivalensis.'[4] M. Lartet has found the same two premolars repeatedly in the upper and lower jaws of *M.*

[1] *Op cit.* p 284.

[2] Brit Foss Mamm p. 274, and Odontography, p 615

[3] Brit Foss. Mamm p 284

[4] *Op. cit.* p 31, Pl xi. figs. 4–6, Pl. xii. figs 8 11. (See vol. i. pp. 68, 127, and 433. Ed)

(*Trilophodon*) *angustidens*.[1] In a manuscript note appended to the work here quoted, with which I have been favoured by M. Lartet, he adds, 'J'ai pu depuis lors vérifier plusieurs fois le remplacement effectif de la 2me et de la 3me molaire de lait, tant à la mâchoire supérieure qu'à l'inférieure comme cela a lieu dans le Dinotherium; la première n'est jamais remplacée.' In a beautiful specimen of the lower jaw of a young *M.* (*Trilophodon*) *angustidens*, belonging to M. Ziegler-Ernst of Winterthur, I found both the penultimate and last premolars present—the former protruded, the latter in germ. When a single premolar is developed, it is the successor to the last milk molar, and not to the penultimate, as stated by Prof. Owen in the passages above referred to.[2] I have seen detached specimens of this last premolar, both of the upper and lower jaws of *M.* (*Tetralophodon*) *longirostris* of Eppelsheim, in the Museum at Darmstadt. The order of succession here indicated is alone consistent with what occurs in other Pachyderms, where, when suppression in either of the milk or premolar series takes place, it is constantly the anterior or feebly developed and rudimentary teeth that are suppressed. In them we never find the last premolar suppressed while the penultimate is developed, but the reverse. The penultimate premolar replaces only the corresponding milk molar: the antepenultimate milk tooth is never replaced in *Mastodon* or *Elephas* so far as observation has yet shown. The molar dentition of the permanent or second set (*i.e.* the premolars and true molars) in *M.* (*Triloph.*) *angustidens* and *Dinotherium* is numerically identical, consisting of two premolars and three true molars; each of these having also two well-developed mandibular tusks: and the close affinity thus indicated by the number of teeth is further borne out by the correspondence of a ternary-ridged formula in two of their 'intermediate molars,' and by other

[1] Lartet, 'Notice sur la Colline de Sansan' (1851), p. 25.

[2] In his subsequent memoir on the molar teeth of *Phacochœrus*, &c. (Phil. Trans. 1850, p. 496), Professor Owen takes a different view of the premolar teeth in *Mastodon* from that set forth in the 'British Fossil Mammalia' and the 'Odontography.' It is expressed thus:—'The existing species of the gigantic Proboscidean family, viz. the Asiatic and African Elephants, are totally devoid of incisors in the lower jaw, and all their grinding teeth succeed each other horizontally; so that it is only by a more than proportional increase of size that the antepenultimate grinder is recognizable as the first of the true molar series, and the antecedent smaller grinders, as the homologues of the milk molars of other Diphyodonts, which milk molars have no successors in the Elephants. In certain Mastodons, however, which are the earliest known forms of the Proboscidean family, the last milk molar was displaced by a vertical successor or premolar.' The tooth, which, in his earliest descriptions, was considered as the successor of the antepenultimate and penultimate (first and second) milk molars, is here regarded as the successor of the last milk molar. But the presence of both the penultimate and last premolars in *Mastodon angustidens* is not recognized.

osteological characters,[1] which leave little room for doubt that they were both Proboscidean genera, *Dinotherium* having close affinities to the Tapirs, as Cuvier sagaciously inferred in his earliest memoir on 'Les Tapirs Gigantesques.'[2]

Of the antepenultimate and penultimate milk molars no specimens from the Crag have been as yet figured or described; but the characters presented by these teeth in *M.* (*Tetraloph.*) *Arvernensis* are well known, both in the upper and lower jaws, through the specimens discovered by Croizet and Jobert, Bravard, and others in Auvergne or the Velay. The antepenultimate presents two ridges, and the penultimate three ridges, with the usual talon complications. They are readily distinguishable—the upper from the lower—when met with detached, from the circumstance that the milk molars of the lower jaw are narrower and more compressed, the antepenultimate being reduced to a single cusp. Figures of these teeth are given by Croizet and Jobert in the work already referred to.[3]

The ridge-formula in the molar teeth of the Crag Mastodon, including milk and true molars, but exclusive of premolars, as inferred from the various data detailed in the previous pages, is—

$$\begin{array}{ccc} \overbrace{\begin{matrix}2+3+4\\2+3+4\end{matrix}}^{\text{Milk molars.}} & : & \overbrace{\begin{matrix}4+4+5\\4+4+5\end{matrix}}^{\text{True molars.}} \end{array}$$

The assigned numbers have not been verified in every instance upon Crag remains; but they are all founded on an examination of specimens, of which some were of foreign origin, when materials were not available from the Crag.[4]

[1] In M. Ziegler-Ernst's Winterthur specimen of the young lower jaw above referred to, five molar teeth are present, viz. the penultimate and last premolars—the former extruded, the latter embedded; the last milk molar far advanced in wear, and immediately over the last premolar; and the antepenultimate and penultimate true molars both in germ, but the former partially emerged and in incipient use.

[2] Annales du Muséum, tom. iii. p. 132.

[3] Oss. Foss. du Puy-de-Dôme, Pl. i. figs. 1–3 and Pl. ii. fig. 7.

[4] In the description of the various teeth throughout this memoir, the terms *antepenultimate*, *penultimate*, and *last* have been used, instead of the numeral expressions of *first*, *second*, and *third*, when designating the position either of the milk or of the permanent molars. This would seem indispensable when symbols are not employed, to avoid confusion in the designation of the milk molars, since the typical *first* or the most anterior of the milk molar series, which is present in many other pachydermatous genera, is constantly suppressed in the Mastodons, and generally also in the Elephants. When, therefore, the terms *first*, *second*, and *third* milk molars are applied to *Mastodon*, they are not the equivalents of the same numerals applied to *Rhinoceros* or *Hippopotamus*, in which all the four milk molars are developed; whereas the terms *antepenultimate*, *penultimate*, and *last* in every case represent homologous teeth in the milk molars of all the ungulate genera. This is the more necessary, as the theoretical *first* or *pre-antepenultimate* milk molar is occasionally met with in the African Elephant. De Blainville (Ostéographie: Des Éléphants, tab. ix. p. 81) has given

Lower jaw.—The characters furnished by the lower jaw are of great significance in distinguishing the nearly allied species of *Mastodon*, more especially in what relates to the form of the symphysis, and the presence or absence of mandibular incisors. The differences between the lower jaws of *M.* (*Trilophodon*) *angustidens*, *M.* (*Tetraloph.*) *longirostris*, and *M.* (*Tetraloph.*) *Arvernensis* are so pronounced that they would have been sufficient to discriminate the species, supposing the molar teeth were unknown to us. As above stated, no good specimen, so far as I am aware, has hitherto been discovered of the lower jaw of the Crag species, *M.* (*Tetr.*) *Arvernensis*, in England; but several have been met with in the Pliocene strata of Italy and France; while abundant remains of the lower jaw of *M.* (*Tetraloph.*) *longirostris* have been disinterred from the Eppelsheim sands by Dr. Kaup, and of *M.* (*Trilophodon*) *angustidens* by MM. Lartet and Laurillard from the Falunian deposits of the Sub-Pyrenees.

First in regard to *M.* (*Triloph.*) *angustidens*. The lower jaw of this species is at once distinguished by the great elongation, downward direction, and slender form of the symphysial portion, which contains the sockets of the two inferior incisors (Plate II. fig. 3).[1] The ascending ramus is of moderate height, corresponding in that respect with *M.* (*Trilophodon*) *Ohioticus* (fig. 2), and approaching that of *Dinotherium giganteum* (fig. 1). The horizontal ramus is very high in front, in a line with the mentary foramen, and low behind; the anterior portion is compressed; and the lower margin stretches some way in front of the mentary foramen, in a straight line; it is then bent a little downwards, and continued forwards in nearly the same straight line; the under surface of the elongated portion forming an obtuse angle with the corresponding surface of the horizontal ramus. The elongation of the symphysial beak is enormous, far exceeding that of *M.* (*Tetra*-

an illustration of its presence in the latter species, on one side of the lower jaw, regarding it as a 'supernumerary' tooth; and a corresponding occurrence in the lower jaw of the same species is represented in the 'Fauna Antiqua Sivalensis' (Pl. xiv. fig. 4 *a*). It is usually restricted to one side, and I regard it as not very uncommon. As the true molars never exceed, nor are below, three in number in the Pachydermata and Ruminantia, the same terms may be conveniently used in describing them. The inconvenience of designating the molars in Mastodon and Elephas by successive numbers ranging from 1 to 6 or 7, which include both milk and true molars without distinction in the same numerical category, is exhibited in the descriptions of the Elephants given throughout by De Blainville in his 'Ostéographie,' and more recently in the otherwise excellent descriptions by Gervais of the dentition of *Mastodon Andium* in the 'Expédition de Castelnau.' The penultimate and last milk molars are there figured and described as the 'third' and 'fourth' molars, involving a confusion of the ridge-formula, which is seen to be of so much importance in the subgeneric distinctions. (Recherches sur les Mammifères Fossiles de l'Amérique Méridionale, 1855, pp. 20–22, Pl. v. figs. 1–5.)

[1] De Blainville, 'Ostéographie: Des Éléphants,' Pl. xiv.

lophodon) *longirostris*, or even of *Dinotherium*; the length from the mentary foramen forwards being more than double that of the horizontal ramus, measured from the same point backwards to the base of the anterior margin of the coronoid process. A constant character of the species is the presence in both sexes of two long, closely adpressed, and straight, or but slightly curved, incisors. This fact has been established by M. Lartet upon a very large number of specimens.[1]

These lower incisors differ notably in form from the upper. In the adult specimens they are nearly of uniform diameter from the base to the point, which is bevelled on the upper side by wear, so as to yield a flat or spathulate surface. In section they are pyriform, with frequently a longitudinal channel on the upper and inner side. The section closely approaches that of the inferior canines of the fossil *Hippopotamus* named *Hexaprotodon Sivalensis.* The tusks or upper incisors of this species are nearly circular in section, and taper gradually to a conical point. They are invested along their length on the inner side by a broad band of enamel, which runs in an obsolete spire, so as to be presented on the upper surface near the tip. M. Lartet has never observed any indication of a belt of enamel on the lower incisors. In the superb complete skeleton which was disinterred by Laurillard at Seissan, the extruded portion of these lower incisors measures 20½ inches, that of the upper tusks being 41 inches. The characters above indicated are constant, wherever the lower jaw of this species has been discovered— whether in the Faluns of the Orleannais and Touraine, in the lacustrine deposits of Gascony and Languedoc, or in the Miocene Molasse of Switzerland, where I found them confirmed by the examination of two very fine specimens, young and old, found in the neighbourhood of Winterthur. They are well shown by the representations given in De Blainville's 'Ostéographie: des Éléphants,' Pl. XIV. The molar teeth in all these specimens have constantly presented the normal marks of the *Trilophodon* division—namely, three ridges to the last milk molar, and to the antepenultimate and penultimate true molars.

In *M.* (*Tetralophodon*) *longirostris* the ascending ramus is considerably more elevated than in *M.* (*Triloph.*) *angustidens*, approaching more the character which is seen in the Elephants proper; the horizontal ramus is less compressed and more circular in section; instead of presenting the greatest height in a line with the commencement of the alveolar border, or mentary foramen, it is contracted there in consequence of the lower margin rising upwards to slope

[1] Lartet, 'Notice sur la Colline de Sansan,' p. 24

off into the base of the symphysial beak (Plate II. fig. 8).[1] This beak is very massive and comparatively short, not exceeding the length of the horizontal ramus, from the mentary foramen to the anterior margin of the ascending ramus. Instead of being, as it were, a deflected continuation of the inferior border of the jaw, as is seen in *M.* (*Trilophodon*) *angustidens*, the beak in the Eppelsheim species is thrown off in a plane nearly parallel with the inferior border, but separated from it and raised above it by a step. It is deflected slightly downwards; but, instead of forming a long slender apophysis as in the other species, it shows a thick mass traversed by a broad gutter. The greater extent of the beak is made up of the alveoli of two mandibular incisors, as in *M.* (*Trilophodon*) *angustidens*. These teeth have not yet been found *in situ*. Kaup has figured three specimens[2] which he conjecturally considers to be lower incisors. The greatest diameter of the largest he states to be 2·75 inches. The molars of these Eppelsheim jaws have constantly exhibited the *Tetralophodon* character of four ridges to the crowns of the intermediate teeth; the ridges being transverse, with the valleys nearly uninterrupted.

In the Pliocene *M.* (*Tetraloph.*) *Arvernensis*, the lower jaw differs widely from that of the other two species. The ascending ramus is well elevated above the grinding plane of the teeth, as in *M.* (*Tetraloph.*) *longirostris*. The horizontal ramus is very massive, without compression, and yields a section which is nearly circular, as in that species. But the symphysis, instead of being elongated into a process composed of the alveoli of two mandibular incisors, terminates suddenly in a short beak, as in the Elephants and other Proboscidean species that are destitute of inferior tusks. This beak does not project much more beyond the anterior rounded surface of the jaw than in the African Elephant, or in *M.* (*Trilophodon*) *Humboldtii*, also a species without mandibular incisors; but it differs from them and all other known species in the diastemal ridges expanding at the point, so as to form a short, blunt, dilated spout. This character is well shown by the Val d'Arno specimen delineated by Cuvier in the 'Ossemens Fossiles,' tom. i. tab. ix. figs. 5 & 6, after Nesti. It is one of the pieces upon which Nesti founded his *Elephas meridionalis*; but which, although the molars are wanting, Cuvier sagaciously inferred, from the general form, to belong to a Mastodon. I was enabled, by the obliging permission of Professor Gaspero Mazzi, to examine the specimen minutely, and to compare it with the numerous lower jaws of *E.* (*Loxodon*)

[1] Kaup, Oss. Foss. de Darmst. tab xix. fig. 1.

[2] Ossemens Fossiles de Darmstadt, tab. iii figs. 1, 2, 3.

meridionalis and of *M.* (*Tetraloph.*) *Arvernensis* contained in the Natural History Museum at Florence, and was satisfied that it belonged to the latter species, as Cuvier had inferred from the drawing. The same Museum contains the greater part of a skeleton of Mastodon, found in a marine deposit of the lower Val d'Arno above Leghorn. The lower jaw of this specimen presents the same character of a short symphysial beak without incisors. The same is exhibited by the lower jaw of the Dusino skeleton from the Astesan, described by Prof. Eugenio Sismonda.[1] They all agree in the common characters, so far as these are shown, of a *Tetralophodon* formula to the crown ridges of the three molars here called intermediate; of alternate mammillæ to the ridges with blocked-up valleys; and of a short obtuse beak with no incisors.

Sismonda describes and figures the lower jaw of the Dusino specimen as being without tusks, or remains of their sockets. But, predisposed to believe that they must have been present at some period of the animal's existence, from their occurrence in other Mastodons, he conjectures that those tusks had fallen out early, and that the alveoli had been obliterated by filling up; and he has given a representation of a very mutilated fragment of a Proboscidean symphysis of the lower jaw as exhibiting the alveoli of two mandibular incisors.[2] I was enabled, by the obliging kindness of Signor Bartolomeo Gastaldi of Turin, to examine the specimen in question, which is very much rolled, and in a different mineral condition from the fossils of the Dusino Mastodon bed, and found that the supposed incisive alveoli were only the anterior terminations of the dentary canals, which are of large size in all the Proboscidea. The form impressed me with the conviction that it was more probably the symphysis of an Elephant than of a Mastodon. This case, therefore, gives no support to the belief that *M.* (*Tetralophodon*) *Arvernensis* had lower incisors.

Professor Owen, in his 'British Fossil Mammalia,' gives a very beautiful representation (p. 291, fig. 101) of a fragment of a tusk discovered by Mr. Fitch in the Mammaliferous Crag-pits near Norwich. He describes it as a portion of the lower tusk of the *Mastodon angustidens*. The specimen is about 15 inches long, with a greatest diameter of 3 inches. It is of a straight, compressed, conical form. The fragment is crushed, and it is manifest that the outer layers of the ivory are detached, and that the original tusk was of a larger diameter than the specimen now exhibits. The marked conical form and great size are irreconcileable with this

[1] Osteograph. di un Mastod. angustidente, tab i. fig. 1.
[2] *Op. cit.* tab. i. fig. 7.

fragment, being referable to an inferior incisor of the Simorre *M.* (*Triloph.*) *angustidens* of Cuvier; and it would seem to me that they are equally irreconcileable with its being considered as a lower tusk of *M.* (*Tetralophodon*) *longirostris*, for the symphysial beak required for the implantation of a tusk of such magnitude would be enormous, and is unknown among any of the species of Mastodon. Professor Owen describes the specimen as being traversed from end to end by a sub-central canal. The same character has been observed in the upper tusks of other fossil Proboscidea, and is nowise characteristic of a lower incisor. I consider that the specimen in question is not a fragment of a lower, but of an upper tusk near the point; and it differs in no important respect from the undoubted upper tusks of *M.* (*Tetralophodon*) *Arvernensis* seen in the Museums of Florence and Turin, which are either slightly curved or twisted in a gentle spiral direction, as represented in the figure given by Sismonda[1] of the Dusino skeleton.

In corroboration of this view, it may be stated that the Indian fossil species which we have named *M.* (*Tetralophodon*) *Sivalensis* is in some respects more nearly allied to the Crag species than the latter is to either *M.* (*Trilophodon*) *angustidens* or *M.* (*Tetralophodon*) *longirostris*. It shows the same alternate character of the mammillæ of the ridges of the 'intermediate molars,' and it appears to have been equally destitute of inferior incisors. I have examined a large number of lower jaws of this species, of all ages, from the sucking calf up to the adult animal, specially with a view to the detection of these teeth, and never observed the slightest indication of their presence in any specimen, whether in the Indian fossil collection of the British Museum, at the India House, or in the rich series belonging to the Asiatic Society of Calcutta.

This completes what I have to bring forward in the shape of descriptive and comparative details, in order to indicate the most prominent diagnostic characters derivable from the teeth and jaws of the Crag Mastodon. I believe that the differences of the three species included by Cuvier under the name of *Mastodon angustidens* will be found to be carried out through all the principal bones of the skeleton. It would be wholly out of place to enter upon such osteographical particulars on the present occasion; but a good idea of the general character of the skeleton in each may be attained by a reference to two well-known standards of comparison, namely, the existing Indian Elephant and the Mastodon of North

[1] *Op. cit.* tab. i. figs. 4 and 5.

America, *M.* (*Trilophodon*) *Ohioticus.* Cuvier found that the latter differed from the Elephant in having a more elongated carcass sustained upon shorter, thicker, and more robust legs.[1] The Crag *M.* (*Tetralophodon*) *Arvernensis* appears to have had a heavy carcass, with legs still shorter in proportion, approaching more the character of the Hippopotamus, and to have been without lower tusks. The Eppelsheim Miocene species, *M.* (*Tetralophodon*) *longirostris*, would appear to have resembled the Crag species in its general proportions; but the necessary detailed comparison has not yet been sufficiently carried out; it is distinguished at once by the possession of inferior tusks. On the other hand, the Miocene *M.* (*Trilophodon*) *angustidens* differed remarkably from both in presenting a comparatively slender build throughout; so that it stood higher in proportion, and with longer limbs, than either the Indian or African Elephants. This is well exhibited by the mounted skeleton in the Paris Museum.

Geological Age of the Mastodons (*M. angustidens*, *M. longirostris*, *and M. Arvernensis*).—I shall now consider the geological age and associated faunas of the formations in which these species severally occur.

M. (*Trilophodon*) *angustidens* is a characteristic species of the Miocene Falunian beds throughout Europe. It has been met with in immense abundance in the lacustrine deposits of Gascony and Languedoc; in the Faluns of Touraine and the Orleannais; in the Miocene Molasse of Switzerland, more especially in the lignites of Ellg, Kœpfnach and Buchberg, and in the sandstone in the neighbourhood of Winterthur; in the Georgensgmund Miocene in Germany; and in the lignite of Gandino in the Val Seriana of Lombardy. The mammalian genera and species with which it was associated are very constant, although, for obvious reasons, they have not been found equally or uniformly distributed all over the area. In the French Falunian deposits there occur *M.* (*Trilophodon*) *Tapiroïdes*, a species first conjecturally named by Cuvier, but subsequently made out well by MM. Pomel, Lartet, and other French palæontologists; *Dinotherium giganteum*, or the smaller variety, as I consider it, called *D. Cuvieri*, *Chalicotherium Goldfussi*, *Anchitherium Aurelianense*, *Aceratherium incisivum* (*Rhinoceros tetradactylus*, Lartet), *Aceratherium Goldfussi* (*Rhinoc. brachypus*, Lartet), *Rhinoceros Sansaniensis*, *Lophiochœrus Blainvillii*, *Macrotherium giganteum*, *Dicrocerus* and *Dorcatherium*, &c.; besides various Carnivorous forms, large and small, with remains of Chelonian genera, together with scanty indications of Crocodile.[2]

[1] Oss. Foss. 4to edit. tom. i. p. 249.
[2] Lartet, 'Notice sur la Colline de Sansan.'

In the Upper freshwater Molasse of Switzerland, *M.* (*Trilophodon*) *angustidens* occurs along with *M.* (*Triloph.*) *Tapiroïdes* (which has been named *Mastodon Turicensis*, as a distinct species, by Schinz and Von Meyer), *Aceratherium incisivum*, *Acerather. Goldfussi*, *Dinotherium giganteum*, *Lophiochærus Blainvillii*, a species of *Tapir*, *Palæomeryx* and other Ruminants, &c., with several species of Chelonians.

M. (*Tetralophodon*) *longirostris* occurs abundantly in the sands of Eppelsheim, associated with *Dinotherium giganteum*, *Chalicotherium Goldfussi*, *Rhinoceros Schleiermacheri*, *Aceratherium incisivum*, *Acerath. Goldfussi*, *Macrotherium giganteum*, *Hippotherium gracile*, and species of *Dorcatherium*, *Machairodus*, *Amphicyon*, &c.

The agreement in so many remarkable generic and specific mammalian forms leaves little room for doubt that the Eppelsheim sands and the lacustrine deposits of the Garonne and other parts of France are of the same Miocene age. But there are some notable peculiarities in the Eppelsheim fauna. No well-marked specimen, so far as I am aware, of *M.* (*Tetralophodon*) *longirostris*, as here defined, has hitherto been met with beyond the limited area of the Eppelsheim sands, and probably the valley of the Danube; nor has either *M.* (*Trilophodon*) *angustidens* or *M.* (*Triloph.*) *Tapiroides*—which usually go together—been discovered within it. It is very improbable that the range of this species should have been confined to a small district in the Valley of the Rhine; but the fact is undoubted, that it occurs there in great abundance, and has either not yet been found, or is very rare, elsewhere. The only exception out of Germany, with which I am acquainted, is a specimen of unknown origin in the Museum of the Faculty of Sciences at Toulouse, which, on the indication of M. Lartet, I was enabled to examine by the kindness of M. Leymerie. It consists of an upper right maxillary containing the penultimate and last molars *in situ*. They present all the characters of *M.* (*Tetralophodon*) *longirostris*, as distinguished from *M.* (*Tetraloph.*) *angustidens*. M. Leymerie informed me that the specimen is supposed to have been found either in Gascony or Languedoc, but that there was no record of the exact locality. It is not improbable that another exception is formed by the specimens mentioned by Cuvier (Oss. Foss. additions, 4to edit. tom. iii. p. 318) as having been discovered by M. Lourteau at Sairac in the Sub-Pyrenees. Two of the molars are described as having the *Tetralophodon* character of four ridges; but, no figures having been given, the details are not sufficiently precise or exact to admit of any decided opinion upon the subject.

A satisfactory geological limitation of the Eppelsheim

deposit and its organic contents is attended with some difficulty. The loose incoherent sand of which it is composed is spread out horizontally like the Löss, and the margin thins out to spread over a portion of the 'Lower Miocene' Mayence Basin; so that where the beds are in contact the fossil remains of the two are liable to be confounded. But in all its leading features the Mammalian Fauna of Eppelsheim resembles that of the Falunian deposits of France and Switzerland.

I shall now consider the relations of the Pliocene fauna in which the Crag Mastodon occurs. *M.* (*Tetraloph.*) *Arvernensis*, as here defined, had a wide range of habitat in Europe, embracing Italy, France, and England. The principal localities in which it has been found are—in Italy,[1] the Val d'Arno (in great abundance), associated with the Elephant called *E. meridionalis* by Nesti (*Loxod. meridionalis*), *Rhinoceros leptorhinus*,[2] *Hippopotamus major*, with species of *Tapirus*, *Sus*, *Equus*, *Ursus*, *Hyæna*, *Felis*, *Machairodus*, &c.; in the marine 'Panchina inferiore,' of the Lower Val d'Arno, an entire Mastodon skeleton was found along with those of extinct Whales;[3] in Piedmont and Lombardy, in various localities in the Sub-Apennine strata along the Valley of the Po, but more especially in the Astesan, Romagnano, and Duchy of Piacenza, along with the *M.* (*Triloph.*) *Borsoni* (*M. Buffonis* of Pomel), a well-marked ternary-ridged species, first brought to notice by Abbé Borson, and the extinct Elephants *E.* (*Loxod.*) *meridionalis*, *E.* (*Loxod.*) *priscus*, and *E.* (*Euelephas*) *antiquus*, and *Rhinoc. leptorhinus*, *Hippopotamus major*, &c., which occur in some places in fluviatile deposits along with species of *Helix*, *Paludina*, and *Clausilia*, and in others in marine deposits along with sea-shells; in France, in various parts of the southern Departments, in Pliocene strata, such as the marine sands of Montpellier and its vicinity, the Valley of the Rhone near Lyons and Trevaux, the Vivarais, Velay, Auvergne, &c.

Great diversity of opinion holds among the French palæ-

[1] 'The Florence Museum is not so rich in Mastodon as in *Elephas meridionalis*. But what I saw, viz. six lower jaws, were all of *Mast. Arvernensis*. The characters were very well marked. The beaks were all short, nearly horizontal, and never inclined downwards or elongated; and they never showed any trace, in young or old, of inferior tusks. They have in the Museum one superb tusk, found along with a skeleton, about 9 feet long by about 4½ inches in diameter, the section nearly round, and the curved direction of the tusk nearly as in the existing Indian Elephant. The tip is very much flattened (not conical), but as I could not see it close enough, I could not determine whether this was owing to a layer of enamel. The Mastodon skeleton was found along with a small Balæna and covered over with oyster-shells.—*Letter to M. Lartet*, Florence, July 17, 1856.—[Ed.]

[2] *Rhinoceros Etruscus*, Falc.—[Ed.]

[3] Savi e Meneghini sulla Geolog. Stratigraph. della Tuscana, p. 508.

ontologists as to the association of the mammalian species among which *M.* (*Tetraloph.*) *Arvernensis* occurs in French deposits. I shall refer briefly, on the present occasion, to the disputed cases at Montpellier or its vicinity, and in Auvergne. De Christol[1] has described the marine sands of Montpellier and the gravel-beds of the contiguous basin of Pézénas as of the same age. From the latter he procured remains of Elephant which he ascribed to the *Eleph. meridionalis* of Nesti, *Hippopotamus major*, two species of *Equus*, one of *Bos*, and two of *Cervus*. Gervais, on the other hand, insists that the gravels of Pézénas are of the age of the Diluvian fauna (Pleistocene), the sands of Montpellier being Pliocene. To the former[2] he attributes *Elephas primigenius*, *Hippopotamus major*, two species of *Equus*, *Bos priscus*, and *Cervus martialis*; and to the latter[3] *Mastodon brevirostre* (*Tetraloph. Arvernensis*), *Rhinoceros megarhinus*, *Tapirus minor*, with species of *Sus*, *Cervus*, *Ursus*, *Machairodus*, *Halitherium*, *Hoplocetus*, &c. M. Gervais does not admit Elephant remains in the Pliocene fauna of Montpellier; but there are two circumstances which diminish the authority of this opinion upon the subject—the first being, that he refers all the fossil elephants found in the South of France to the Mammoth, *E. primigenius* of the Diluvian fauna, of which he considers *E. meridionalis* to be a variety; the second, that he does not admit that any species of fossil Elephant have been discovered anywhere in Pliocene strata in Europe. He considers that in the instances asserted by Croizet, Christol, Marcel de Serres, and others, Mastodon bones have been mistaken for those of Elephant.[4] But, putting aside the disputed French cases, it will be seen in the sequel that there are undoubted instances of the occurrence of remains of Mastodon and Elephant in the same strata in the Sub-Apennine beds of Italy and in the Crag of Norfolk. In Auvergne and the Velay, the lacustrine and regenerated alluvial strata of all ages, from the Miocene up to the Post-Pliocene, have undergone such complicated disturbances from successive volcanic eruptions, that great difficulty has been experienced in separating the members of the various faunas, more especially of the subdivisions of the Pliocene and later period. The utmost diversity of opinion holds among the palæontologists who have paid most attention to the later types of the fossil Mammalia of Auvergne, regarding the groups of species which were coexistent at different times. Without going into details, I may observe that Bravard has endeavoured to make out three distinct faunas after the

[1] Annales des Scien. Natur. 2 sér. tom iv. p. 193.

[2] Paléontol. Franç. tom. ii. descript Pl. xxi.

[3] *Op. cit.* tom. ii descript. Pl. xxx.

[4] Gervais, *op. cit.* tom. i. p. 36.

Miocene lacustrine beds of the Limagne: 1st, a *Mastozoic*, or Pliocene fauna, characterized by the presence of species of *Mastodon* and the absence of Elephants, Horse, and Hippopotamus; 2nd, an *Elephantine* fauna, comprising these genera; and 3rd, a *Diluvian* fauna, in which Elephants and Rhinoceros, &c. are wanting.[1] Pomel, on the other hand, in his last detailed memoir, has attempted to distinguish after the Miocene lacustrine deposits of the Limagne; 1st, a Pliocene fauna, characterized by two species of Mastodon, a Rhinoceros, Sus, Tapir, and twelve or fourteen species of Cervus, but no Elephants; 2nd, an alluvial fauna, which he divides into two distinct series of different ages: the one more ancient, comprising *Elephas meridionalis*, *Rhinoceros leptorhinus* and *Rhinoc. Aymardi*, *Hippopotamus major*, *Tapirus elegans*, *Ursus spelæus*, *Bos priscus*, *Megantereon latidens*, and two species of Deer, &c.; the other, more modern, consisting of *Eleph. primigenius*, *E. priscus*, *Rhinoceros tichorhinus*, *Hyæna spelæa*, *Cervus Guettardi*, &c.[2] But there are grave objections to both these arrangements, inasmuch as the association of the species does not correspond with what holds elsewhere in the Pliocene and Post-Pliocene deposits of Italy, England, and Germany, which are free from the volcanic intrusions that have overwhelmed and confused the deposits of Auvergne. It suffices for my purpose on the present occasion, to state that, where *M.* (*Tetralophodon*) *Arvernensis* occurs in Auvergne and the Velay, the same species are met with in different localities as are found together in the same Pliocene stratum in the plains of Piedmont and Lombardy, namely, *M.* (*Trilophodon*) *Borsoni*, *Rhinoceros leptorhinus*,[3] *Hippopotamus major*, and the Elephants called *E.* (*Loxodon*) *meridionalis* and *E.* (*Loxodon*) *priscus* (?), with species of *Tapirus*, *Sus*, *Cervus*, &c. The numerical agreement of the Auvergne fossil species with those which occur in the richer fauna of the Val d'Arno is still more considerable. But it is, at the same time, to be remarked, that at the late Meeting of the 'Congrès Scientifique' of France, held at Puy in Sept. 1855, MM. Croizet, Aymard, and Pichot[4] were agreed that the Mastodon remains in the Velay and Auvergne were of an older age than the beds containing Elephant remains.

Mastodon of the Crag.—I shall now pass under review the circumstances under which *M.* (*Tetralophodon*) *Arvernensis* occurs in British strata.

[1] Bravard, cited by Pomel, 'Bullet. de la Soc Géol. de France,' 2e sér. tom. iii. p. 178 *et seq.*

[2] Pomel, *loc. cit.* and Catalog. Méthod. et Descript., &c. 1854, pp. 172–184.

[3] Written in 1856.—[Ed.]

[4] Congrès Scientifique de France, 1855, tom. i. p. 325.

First, in the 'Fluvio-marine' or 'Norwich Crag.' Undoubted remains of this species have been discovered in this deposit: at Whitlingham by Mr. William Smith; at Horstead, by Messrs. Layton, S. Woodward, and Gunn; at Postwick, Thorpe, and Norwich, by Messrs. Fitch and Wigham; at Bramerton, by Mr. S. Woodward and Capt. Alexander; and in Suffolk, at Easton and Sizewell Gap, by Capt. Alexander. *The entire skeleton, of which so circumstantial an account has been given by the Rev. Mr. Layton, is stated to have been found on the surface of a bed of marl,* 'between the chalk and gravel,' at Horstead, without indicating the precise relation of the bed to the Crag and the superincumbent blue clay or submerged forest-bed. I have examined the most of these specimens, either in original or as casts, at the Museums in Norwich and London, and found them all referable to the species, as here limited.

Various statements have been made by different writers regarding the fossil Mammalia associated in the Fluvio-marine Crag, with the *Mastodon* or without it. Mr. William Smith's celebrated Whitlingham specimen is said to have been found along with the horns of Deer and Crag-shells.[1] Mr. R. C. Taylor[2] mentions that the Crag of Bramerton has yielded 'the Mastodon, the Elephant, the Gigantic Elk, and the Enormous-horned Bison.' Mr. Charlesworth[3] states, that bones of Elephant and other herbivorous animals are more frequently associated with shells in the Mammaliferous than in the Red Crag, but he does not mention what the species are. Sir Charles Lyell,[4] in his memoir on the 'Relative Ages of the Norfolk and Suffolk Crag,' states that the Fluvio-marine Crag, near Southwold, has yielded the remains of the Elephant, Rhinoceros, Horse, and Deer, mixed with marine, terrestrial, and freshwater shells; and that in the inland pits near the same place he found mammalian remains associated with the *Cyrena trigonula* of Grays and elsewhere. He mentions, that 'the horns of Stags, bones and teeth of Horse, Pig, Elephant, and other quadrupeds,' associated with *Mastodon*, had been obtained at Postwick, Thorpe, Bramerton, and other localities near Norwich. The tusk of an Elephant was obtained at Bramerton, covered with *Serpulæ*, showing that it had lain for some time at the bottom of the sea of the Norwich Crag.[5]

Professor Owen in the conspectus of genera and species contained in the introduction to his 'British Fossil Mammalia,'

[1] Taylor, Geology of East Norfolk, 1827, p. 14.

[2] *Loc. cit.*

[3] Phil. Mag. 3rd ser. vol. vii. 1835, p. 89.

[4] Geol. Proc. vol. iii. p. 127; and Mag Nat. Hist. new ser. vol. iii. p. 316.

[5] *Op. cit.* p. 128.

enumerates in the list of the fossils of the Pliocene Fluvio-marine Crag the following genera and species, viz. *Mastodon angustidens*, *Elephas primigenius*, *Rhinoceros tichorhinus*, *Equus fossilis*, *Cervus elaphus*, *Arvicola*, and *Lutra*. But, influenced probably by the opinion at which he had arrived, that the Crag *Mastodon* was identical with the *M. angustidens* of Cuvier and *M. longirostris* of Kaup, he adds in a note, that all the other species, except *Mastodon*, were probably derived from the overlying blue clay.[1] The contemporaneous association of these species is unquestionably in the highest degree improbable, as it would include a Miocene Mastodon along with a Post-Pliocene Elephant and Rhinoceros, and the existing Red Deer, in the same fauna. But it admits of no doubt that species of the genera above enumerated have been found in the Fluvio-marine Crag, and it is of importance to ascertain what these species really are. I carefully examined the Elephant molars from the Crag, blue clay, or submerged forest-bed, contained in the different collections at Norwich, and arrived at the conclusion that none of them belonged to *E. primigenius*, the Mammoth of Siberia, properly so called; but to two distinct species, the one, *E.* (*Loxodon*) *meridionalis*, which occurs in vast abundance in the Val d'Arno; and the other, *E.* (*Euelephas*) *antiquus*, which is found in the plains of the Astesan, in Piedmont, in various other parts of Europe, and in the so-called 'Newer Pliocene' freshwater deposits and caves of England. The evidence upon which these species are founded will be considered in the sequel. The occurrence of the Siberian *Rhinoceros tichorhinus* (*Rhin. antiquitatis* of Blumenbach) in the Crag would seem exceedingly improbable; for, elsewhere, it has invariably been met with in company with the Mammoth, in the northern fauna of the Glacial Drift period, and nowhere as yet, upon undoubted evidence, in Pliocene formations. Professor Owen (Brit. Foss. Mamm. p. 381) states, that 'Mr. Fitch of Norwich possesses specimens of upper and lower molar teeth of the *Rh. leptorhinus* from the freshwater (lignite) beds on the Norfolk coast near Cromer, which demonstrate the occurrence of this species in the same deposit with the *Rh. tichorhinus*.' The contemporaneous association of the two species in these beds would seem as improbable as the occurrence of *Rh. tichorhinus* in the Crag, and the explanation may be sought for in an adventitious mixing of the specimens.[2] The evidence adduced in support of the existing

[1] *Op. cit* p. xlvi.

[2] Mr Charlesworth, in remarking that the bones of Elephants and other quadrupeds are more frequently associated with the shells of the Crag in Norfolk, adds that, 'in that county the formation in many places exhibits such irregularities, and is sometimes so mingled with

common Otter (*Lutra vulgaris*[1]) and Red Deer (*Cervus elaphus*) having also been found in the same deposit, would require to be very conclusive before the facts alleged could be received as well established. For no fewer than eight species of *Cervus*, belonging to the subgenera *Rusa* and *Strongyloceros*, with round antlers, have been described by the French palæontologists as occurring in the Velay and Auvergne, besides eleven other species in Pliocene or Post-Pliocene strata.[2] Several species with round-antlered horns have also been obtained from the Val d'Arno, which would seem to be identical with Auvergne forms (making liberal allowance for *doubles emplois* in the specific names), and it is much more probable, from the agreement in the other associated mammals that the Crag species belonged to one of these than to the existing *Cervus elaphus*.[3] *Hippopotamus major* and *Rhinoceros leptorhinus*,[4] if not hitherto obtained from the Fluvio-marine Crag, occur in abundance either in the blue clay or in the ancient forest or lignite-bed, which immediately overlies the Crag in the sections along the Norfolk Coast; and evidence will be adduced in the sequel, that these beds are of the same Pliocene age, in so far as is shown by the paramount proof of identity of mammalian fauna. Taking together the ascertained fossil Mammalia of these two beds, they agree very closely with the Pliocene fauna of the Sub-Apennines, viz. *M.* (*Tetralophodon*) *Arvernensis*, *E.* (*Loxodon*) *meridionalis*, *E.* (*Euelephas*) *antiquus*, *Rhinoceros leptorhinus*, *Hippopotamus major*, large *Bovidæ*, and large Deer with round-antlered horns. Among the Proboscidean forms the principal exception is the absence of the Mastodon here called *M.* (*Trilophodon*) *Borsoni* from the Crag and blue clay. This species, which occurs both in the Astesan and Auvergne and other parts of France, is so nearly allied to the Mastodon of North America that the first discovered European specimens were regarded

immense accumulations of sand and gravel, that it becomes almost impossible to distinguish the specific Crag deposit from the accompanying diluvial strata.'—Phil. Mag. 3rd ser. vol. vii. p. 89.

[1] Owen, Brit. Foss. Mamm. p. 121.

[2] Pomel, Catal. Méthod. et Descript. p. 103.

[3] Gervais has expressed doubts respecting the veritable association of these living with extinct forms:

'Il est également à supposer, que les nouvelles recherches des géologues d'Angleterre démontreront aux paléontologistes de ce pays que certains animaux reconnus par M. Owen comme étant d'espèces actuelles n'ont pas appartenu, comme ils le supposent, à l'époque pliocène. Tels sont le Cerf, la Loutre, et le Sanglier ordinaires. Le *Rhinoceros tichorhinus*, que nous considérons comme caractéristique du pléistocène, nous paraît aussi devoir être rayé de la liste des animaux pliocènes. On pourrait supposer qu'il s'est glissé quelque ereur dans la détermination des pièces osseuses, regardées comme telles, mais cette détermination est garantie par la citation que M. Owen fait de cette espèce dans sa liste chronologique des Mammifères fossiles en Angleterre, et il est plus probable que c'est sur l'âge du terrain lui-même que l'on s'est trompé.'—Gervais, Paléontol. Française, tom. i. p. 180.

[4] See note 3, p. 49.—[Ed.]

by Cuvier[1] as belonging to that species; but its specific distinctness has been clearly established by the French palæontologists, and its occurrence in the Crag or overlying beds may yet be expected, if it has not been heretofore overlooked by collectors. The species would seem to be exceedingly rare in Italy, since tooth specimens referable to it are either unique or nearly so in the public collections there.

Next, as regards the 'Red Crag' of Suffolk. Mammalian remains were formerly so rare in the 'Red Crag' that their abundance in the Norwich Crag was seized upon by Mr. Charlesworth as furnishing a significant designation for the latter under the name of 'Mammaliferous Crag.' But latterly the excavations for phosphatic nodules have led to the discovery of these remains in abundance. Among others, molars of *M.* (*Tetralophodon*) *Arvernensis* have been obtained in very considerable numbers. By the liberal kindness of Professor Henslow, I have been enabled to examine at leisure those which are contained in the Ipswich Museum, presented to that institution by Mr. George Ransome. They were found in the Red Crag pits. Some of these remains are now on the table before the Society. One, a very characteristic specimen, consists of the greater part of the last true molar, upper jaw, left side. It presents all the distinctive marks of *M.* (*Tetralophodon*) *Arvernensis*, namely, the discs of the worn tubercles decidedly alternate, and the valleys blocked up by large outlying tubercles. These 'Red Crag' molars differ in no respect specifically from those found in the Fluvio-marine Crag. They are highly impregnated with ferruginous infiltration, and present a vitreous polish, very much like that of the Mastodon molars from Perim Island on the western coast of India. They are mutilated by fracture, but do not present the appearance of having been rolled. The fractured edges of the enamel are sharp; and the only indications of abrasion which the teeth present are the natural results of wear, from long service as grinders. This is a point of some importance, as indicative that they were not washed into the Red Crag out of some older Miocene deposit.

Mr. Charlesworth, in his memoir on the 'Crag of Suffolk,' &c., after enumerating the genera of fossil fish that prevailed in the ocean of the Red Crag, adds—'It is here also that we first meet with the higher orders of the animal kingdom. The teeth of the Mastodon, Elephant, Hippopotamus, and other *Mammalia* are deposited with the *Mollusca* of this period, and in addition to them I may mention the bones of *Birds*, which I have recently obtained from several localities.'[2]

[1] Oss. Foss. 4th edit. tom. iii. p. 375. [2] Phil. Mag. 3rd. ser. vol. viii. p. 535.

Professor Owen has on three occasions described the fossil mammalia of the Red Crag: first, in 1840;[1] next, in his 'British Fossil Mammalia' in 1846; and latterly, as a Supplement, in No. 47 of the 'Quarterly Journal of the Geological Society.'[2] In neither has he included two of the genera cited by Mr. Charlesworth, viz. *Elephas* and *Hippopotamus*, both being of great significance as diagnostic of the age of European tertiary strata. No specimen of a tooth of *Hippopotamus* from a Red Crag locality, so far as I am aware, has hitherto been figured or described; and the occurrence of this genus in the deposit cannot at present be regarded as an established fact; but several molars of fossil *Elephas*, presenting the characteristic mineral condition of the Mammalian remains of the Red Crag, have long been deposited in public and private collections, bearing labels as being from Red Crag localities in Suffolk. One specimen, in particular, in the Museum of Practical Geology, is marked as being from Felixstow, and other reputed instances of the same kind will be noticed in the sequel.

In the 'Conspectus' contained in the 'British Fossil Mammalia,' Prof. Owen enumerates, as Mammalia of the 'Miocene Red Crag,' remains of *Ursus*, *Meles*, *Felis pardoides*, *Sus*, and *Cervus*. But he adds in a note, that 'the nature of the stratum renders the actual age of these fossils doubtful.' To the enumeration of the five Eocene species of *Cetacea* in the same conspectus, he appends a note, 'that most of them occur in the Miocene Crag, but there is little doubt that they were washed out of the underlying Eocene clay.' The 'Cetotolites' in question were discovered by Professor Henslow in the Red Crag at Felixstow,[3] which has yielded abundant Mammalian remains of herbivorous quadrupeds. In his late paper, Professor Owen gives an account, more or less detailed, of the remains of twelve species of Mammalia (exclusive of *Cetacea*) from the Red Crag, belonging to the genera *Rhinoceros*, *Tapirus*, *Sus*, *Equus*, and probably *Hipparion*, *Mastodon*, *Cervus* (of the subgenera *Dicranoceros* and *Megaceros*), *Felis* (two species), *Canis*, and *Ursus*. He sums up the following conclusion, which, from its importance, I quote *in extenso*:—

'From the foregoing details it will be seen that the researches now applied during fifteen years to the Mammalian fossils of the Red Crag of Suffolk have led to the very interesting result, that the majority of them are identical, or closely correspond, with Miocene forms of Mammalia, and especially with those from the Eppelsheim locality, described

[1] Ann. and Mag. of Nat Hist vol. iv p. 186

[2] *Op. cit.* 1856, vol. xii p 217

[3] Quart. Journ. Geol. Soc. vol. i. p 37.

by Prof. Kaup. In Suffolk, as in Darmstadt, we find the *Mastodon longirostris*, *Rhinoceros Schleiermacheri*, *Tapirus priscus*, *Sus palæochærus*, and *Cervus dicranoceros*, associated together in the same formation; and, with these Miocene forms of extinct Mammalia in the Red Crag, we have likewise a Cetacean which most closely resembles a Miocene species of that order, previously recognized in the Crag or Molasse of the Continent. At the same time there are, as *e.g.* in the *Megaceros*, specimens of newer Pliocene or Pleistocene forms of Mammalia mingled with the older tertiary species; whilst, on the other hand, Eocene forms of fish, as, *e.g.* *Edaphodon*, with *Myliobatidæ* and Eocene Crustacea, have been obtained from the Red Crag pits.

'As, however, several of the Mammalia which occur in Miocene formations are also found in the older Pliocene deposits in parts of France, it would be rash, perhaps, to pronounce positively on the Miocene age of any of the above-cited Crag fossils; but it is certain that the majority of those Mammalian fossils, and by far the greatest proportion of individual specimens, belong to an older tertiary period than the Mammalia of the newer Pliocene drifts, gravels, brick-earths, and bone-caves.' (*Loc. cit.* p. 229.)

In this view, regarded in the most restricted sense, a very mixed origin and complex character are attributed to the Mammalian fossils of the Red Crag, and it would seem to be open to several objections, some of which I shall now state. Professor Owen, having satisfied himself that the Mastodon of the Crag was identical with the Miocene species of Eppelsheim, was naturally predisposed, where the evidence was at all ambiguous or indecisive, to regard the remains of the other fossil Mammalia with a leaning towards a Miocene origin. First, as regards the *Rhinoceros*; the European fossil species of this genus, including *Acerātherium*, are at present involved in such a maze of confused synonymy that no two living palæontologists are agreed about the number, or upon the names which ought to be applied to them. In consequence, it is exceedingly difficult to arrive at any satisfactory conclusion where a fossil Rhinoceros older than the Siberian species forms an element of the discussion. In the 'British Fossil Mammalia,'[1] Professor Owen adopts the opinion of Christol, that *Rhin. Schleiermacheri* and *Rhin. megarhinus* are synonyms of the same species, the former having been founded by Kaup upon Miocene remains discovered at Eppelsheim, the latter by Christol upon Pliocene remains from Montpellier. From his late memoir it would appear that he now considers

[1] *Op. cit.* p. 370.

them distinct, and he leans doubtingly towards the opinion that the Crag molars of this genus, upper and lower, belong to the Miocene *Rhin. Schleiermacheri*, rather than to *Rhin. megarhinus*. But without going into details, it may be stated that these teeth present no characters, so far as they have been described, inconsistent with their being referred to the so-called *Rhin. megarhinus* of the South of France and Italy. The premolars possess the basal 'bourrelet' which Christol pointed out as one of the distinguishing marks of his *Rhin. megarhinus*; it occurs, as stated by Professor Owen, in the same teeth of *Rhin. Schleiermacheri*, and it is met with also in the premolars of the *Rhin. leptorhinus* of Cuvier. Further, it would seem to be clearly established now, that Cuvier was quite correct in characterizing his *Rhin. leptorhinus* as destitute of a nasal bony septum, and that Christol was misled by the deceptive appearance of a drawing in assigning this peculiarity to the original Italian specimen, and confounding it with *Rhin. tichorhinus*.[1] There are also the strongest grounds for believing that the *Rhin. megarhinus* of the Pliocene sands of Montpellier is specifically identical with *Rhin. leptorhinus* of Cuvier. The Red Crag specimens, figured and described by Professor Owen, are undoubtedly very like the corresponding teeth of *Rhin. Schleiermacheri*; but it seems to me that the materials are not sufficient to establish a satisfactory palæontological identification, and that it is at present an open question whether they belong to *Rhin. leptorhinus* of Cuvier, or to *Rhin. Schleiermacheri* of Kaup. The same remark applies to the Tapir of the Red Crag, which Prof. Owen refers, on the evidence of a single upper and single lower molar, to the Miocene *Tapirus priscus* of Kaup. Pliocene species of Tapir have been met with both in Italy and France, one of which has been named *T. Arvernensis* (Croizet and Jobert), and the other *T. elegans*[2] (Pomel); and a supposed third species, *T. minor* of Marcel de Serres, has been yielded by the marine sands of Montpellier.[3] The adduced evidence would seem hardly sufficient to establish that the Crag molars do not belong to either of these.

[1] Cornalia, in Duvernoy's 'Nouvelles Études sur les Rhinoc Fossiles' (Archiv. du Muséum, tom. vii. p. 99). He describes the original specimen, which is deposited in the Natural History Museum at Milan, as perfectly free from any trace of a bony septum, whether along the median line of the nasals or upon the floor of the nasal cavity. Christol, not having had access to the specimen, misinterpreted a shaded portion of a drawing of it as a representation of the septum. Dr. Cornalia's remarks confirm, in every essential respect, the previous description by Cuvier.

[2] Pomel, Catal. Méthod. et Descript. p. 84.

[3] Gervais, Paléontol. Française, tom. ii. p. 4, Pl. v. figs. 4 & 5. Gervais doubts, with De Blainville, whether the materials are sufficient at present to prove that these Pliocene nominal species really differ from the *Tapirus priscus* of Eppelsheim.

So also in regard to the Crag *Suidæ* referred by Professor Owen to the Eppelsheim species, *Sus palæochœrus* and *Sus antiquus* of Kaup. The Crag specimens upon which the identification is founded are limited in each case to a single detached upper molar. The tooth referred by Prof. Owen to *Sus palæochœrus* assuredly bears a very close resemblance to the figure of that of the Eppelsheim species with which he compares it; but the evidence, it must be admitted, is too limited to bear out a satisfactory specific identification; for aught that is shown to the contrary, except a slight difference of size, both of the Crag teeth may belong to the same species. An extinct species of *Sus*, *S. Arvernensis* of Croizet, has been found in the Pliocene strata of Auvergne; another supposed species, *S. provincialis* of Gervais, in the marine Pliocene sands of Montpellier; and species, as yet undetermined, of the same genus, occur in the Pliocene deposits of Italy. Is it certain that the 'Red Crag' molars of *Sus* differ from all these?

The *Equus* of the Red Crag is stated by Professor Owen to resemble in the molar teeth his *Equus plicidens* of the Oreston Cavern, reconcileable with a Pliocene origin. The evidence respecting the teeth of the form considered by Prof. Owen 'as probably of the subgenus *Hipparion*' has not been adduced. This subgenus had hitherto been regarded as strictly confined to Miocene strata, but Gervais[1] has attempted to distinguish several species from the marl beds of Curcuron in the Vaucluse, the age of which, whether Miocene or Pliocene, he alleges, still remains to be determined.

As regards the two Cervine Ruminants from the Red Crag the determination of the form which Prof. Owen refers to *Cervus dicranocerus* of Eppelsheim rests upon two shed antlers and two detached molars. The horns undoubtedly closely resemble those figured by Kaup of that species; but, as Prof. Owen states, a species presenting the rare character of a similar bifurcate form of antler, and named *Cervus australis* by Marcel de Serres,[2] has been discovered in the Pliocene marine sands of Montpellier; and it has not been shown that the Crag form differs specifically from it. The identification which is most at variance with the conclusions hitherto accepted is that of the shed antler, said to be from a Crag pit at Felixstow, which Professor Owen (in the reference to the figure) describes as the 'base of the antler of the *Megaceros Hibernicus*;' inferred to occur in a formation where the majority of the Mammalian species are regarded as Miocene.

[1] Paléontol Française, tom i. p. 177.

[2] Gervais, Paléontol. Française, tom. i. p. 85. Pl vii. figs. 1–3.

Any determination emanating from so distinguished a palæontologist as Professor Owen must be entertained with the respect which his great authority carries with it. But the specimen in question, although (like most of the fossils of the 'Red Crag') highly impregnated with iron, and of corresponding gravity, is encrusted with fresh patches of *Lepralia Peachii*. Prof. Busk, to whom I am indebted for this identification, after a careful examination of the original, informs me that the pearly appearance and transparency of the walls of the cells indicate the modern origin of this marine Bryozoon. Other species of the same genus are found in abundance upon the fossil shells of the Red Crag, but they are invariably more or less tinged with an ochreous colour, and the walls of the cells are opaque. Instead, therefore, of having been found in a Crag pit (the statement under which the specimen came before Professor Owen), it would seem most probable that it was dredged out of the present sea, from some locality off the coasts of Suffolk or Essex. Teeth and bones of Elephants and of other herbivorous mammalia, highly impregnated with iron, and encrusted with marine Bryozoa, are brought up by the dredge, or found upon the beach, at intervals all along the coast from Mundesley to Harwich. A large number of molars of *Elephas* (*Loxod.*) *meridionalis*, presenting a highly vitreous polish, heavy, and dark-coloured, exist in Mr. Fitch's collection at Norwich; and analogous remains are to be met with in various collections in Suffolk and Essex; yet it is not a little remarkable, considering the numerous descriptions of the coast section which have been made by different English geologists, that the particular beds from which these remains have been derived have not yet been determined with precision. No authentic case has as yet been made out of remains of the Irish Elk in strata of an older date than the period of the Mammoth, Siberian Rhinoceros, and *Ursus Spelœus* of the Glacial fauna; and the palæontological evidence would require to be very conclusive before the range of this species could be extended so as to include the Pliocenes of the Sub-Apennine period.

As regards the Carnivora of the 'Red Crag' enumerated by Prof. Owen, the evidence, so far as it has been published, is of a very limited nature, being confined to detached teeth, and is adequate for little more than the identification of the respective genera. No Miocene species of *Ursus* has yet been met with in Europe. The tooth from a Red Crag pit at Newbourn, which Professor Owen guardedly describes as 'somewhat smaller than the corresponding tooth of the *Ursus spelœus*,' would correspond in size with that of the Pliocene *Ursus Arvernensis*, found abundantly in Italy and

Auvergne. Professor Owen admits that the carnassial teeth specimens, from Newbourn and Woodridge, of his *Felis pardoïdes*, do not differ in size from the Pliocene *Felis pardinensis* of Croizet and Jobert, found in Auvergne, and it remains to be shown that the former is specifically different from the latter form. The remarkable sectorial tooth from the Red Crag, which, according to Professor Owen, closely resembles one of the ancient Carnivora called *Hyænodon* and *Pterodon*, and which he suspects to be an indication of an extinct osculant genus, linking on the true Felines to the Hyæna or Musteline family, has not been generically determined; and it may have been washed in from strata of the Eocene age.[1]

If, on the other hand, a palæontologist, having satisfied himself that the Red Crag Mastodon is an undoubted Pliocene form, and finding the same species in the Fluvio-marine Crag, were to infer that they were both of the same geological age, and if he were then to take a group of some of the well-established species as a starting point, he would experience little difficulty in reconciling many of the more doubtful Mammalian species with a consistent Pliocene association. The species would run in the following order:—The Proboscidea, *M.* (*Tetralophodon*) *Arvernensis*, *E.* (*Loxodon*) *meridionalis*, and *E.* (*Euelephas*) *antiquus*; the Pachydermata, *Rhinoceros leptorhinus* or *Rhinoc.* ——?, *Tapirus Arvernensis*, and *Equus plicidens*; the Carnivora, *Felis pardinensis*, *Ursus Arvernensis*, and probably a Pliocene species of *Canis*. With such an harmonious agreement in the great leading forms, he would naturally look to Pliocene forms for comparison when he met with scanty and indecisive remains of such a widely distributed and extensive genus as *Cervus*, unless the characters were so pronounced as to be decisive of species of an earlier age.

This is the manner in which I have been led to regard the fossil Mammalia of the Red and Fluvio-marine Crag; and it has appeared to me that (where remains obviously of an anterior epoch have not been adventitiously intermixed) they agree generally, so far as the species have been well determined, with the great Pliocene fauna of Italy, as exhibited along the valleys of the Po and of the Arno. But it must at the same time be freely admitted, that the materials upon which the determination of many of the species of the Red Crag Mammalia at present rests are so scanty and indecisive,

[1] Quarterly Journal of the Geol. Soc. vol. xii. p. 237, fig. 20.

that the identification, either way, whether as Miocene or Pliocene forms, must be regarded as little more than approximative.

There are other considerations which corroborate the Pliocene view of the Mammalian fauna of the Crag. The debateable species referred by Prof. Owen to a Miocene origin all belong to genera that are common to the Miocene and Pliocene periods, such as *Mastodon*, *Rhinoceros*, *Tapirus*, *Sus*, *Cervus*, and *Felis*. But of the more remarkable types which are limited to the upper Miocene deposits, and which abound in them all over Europe, such as *Dinotherium*, *Chalicotherium*, *Aceratherium*, *Anchitherium*, *Amphicyon*, &c., not a single remain has ever been cited as having been found in the Crag deposits. The question naturally arises, how does it happen, if the majority of the Red Crag Mammalia are Miocene, that there has been this selective admixture of species of long-termed 'Miocene' genera in the Crag, and why the exclusion of the strictly characteristic genera?

Another view may be taken, that, as the Red Crag contains Fish and Crustacean remains which have been inferred to have been washed out of denuded Eocene deposits, so the Pliocene sea-bottom of the Red Crag may have had Miocene mammalian remains washed into it, thus causing an extraneous admixture among the Pliocene mammalian fossils. But it may be asked in reply, where are the Falunian deposits, in proximity with the Crag in England, from which such a washing-in could have taken place? And, if they were transported from a distance, they ought to show marks of abrasion from rolling, which, so far as my observation goes, are not seen in a great many of the Red Crag Mammalia to which a Miocene origin has been attributed. Many flattened pieces of bone, exhibiting a high vitreous polish, and bearing palpable marks of having been long rolled in the sea among shingle, have unquestionably been met with in the Crag; but it does not necessarily follow that they were all washed out of an older deposit. It is intelligible that the effect may have been produced by attrition caused by the waves of the Crag-sea upon bones of animals of the same geological period.

It now remains to consider how far the Cetacean fossils of the Crag are in accordance with the inferred Pliocene character of the Land Mammalia. Professor Owen has described 'Cetotolites' of five species of *Balænidæ* from the Red Crag. He states (Brit. Foss. Mam., p. 527), that they 'appear to have been dislodged from a subjacent Eocene deposit;' and the same opinion is repeated in the note appended to the

'Conspectus' of British fossil species which I have already cited. They are there arranged under the head of Eocene, and excluded from the Miocene fossils. Cetacean remains have been met with in abundance in the Pliocene deposits of Italy, under circumstances which leave no doubt that they are of the same age as the land quadrupeds found associated with them. I have already mentioned the case examined by myself, where the skeleton of *M.* (*Tetraloph.*) *Arvernensis*, covered with marine incrustations, was found in the 'Panchina inferiore' of the lower Val d'Arno near Leghorn, associated with the entire skeleton of a whale referred by the Italian naturalists to *Physeter*, and with Dolphin remains. A still more remarkable and conclusive instance is furnished by the rich and well-known deposit of Pliocene Mammalia investigated by Cortesi in the Sub-Apennine deposits near Piacenza. Monte Pulgnasco is stated to attain an elevation of about 1,700 feet above the level of the Adriatic,[1] and near it there are lower elevations, Monte Zago and Della Torazza. The upper beds in all three alike, to a great depth, consist of reddish calcareous sands full of marine shells; and below these there are beds of blue clay ('Marna cerulea'), also loaded with similar shells, both being of the Sub-Apennine Pliocene age. Cortesi discovered in the blue clay, at different points, nearly entire skeletons of extinct whales, referred by Cuvier to the Rorquals (*Balanoptera Cortesii* and *Balanoptera Cuvierii*[2]), and of Dolphins allied to *Phocana Orca*, but differing in the form of the cranium (*Phocæna Cortesii*,[3] and other species unnamed). Near the summit of Monte Pulgnasco, in the overlying stratified sands, the greater part of a skeleton of the Val d'Arno Elephant, *E.* (*Loxod.*) *meridionalis*, was discovered; and upon Monte Zago the original skull, together with many other bones, of the individual Rhinoceros upon which Cuvier founded his *Rhinoc. leptorhinus* as distinct from *R. tichorhinus*. The Rhinoceros skeleton was found in the sandy strata, but resting immediately upon the blue clay, and with upwards of 200 feet of strata above it. I was enabled, by the kind permission of Dr. Emilio Cornalia, to examine the fine collection of these Monte Pulgnasco remains deposited in the Natural History Museum at Milan, including, among others, the palate specimen of the Elephant described by Cortesi,[4] which I found to be identical with *E.* (*Loxodon*) *meridionalis* of the Val d'Arno and fluvio-marine Crag.

Here are two cases of the association of Pliocene Cetacea with terrestrial Mammals, under circumstances where extra-

[1] Cortesi, Saggio Geolog 1819, p 72

[2] Diction Univers. d'Histoire Natur. tom. ii p. 443.

[3] *Op. cit* tom. iv. p. 634.

[4] Cortesi, *op. cit.* p. 68, pl. vi, figs. 1, 2

neous admixture is inadmissible. Cetacean remains were long ago described by Cuvier from the Crag of Antwerp.[1] Lyell found in the same formation numerous specimens of bones said to be of *Balænoptera* and *Ziphius*, which bore no marks of rolling as if washed out of older beds; and he inferred that the animals to which they belonged once co-existed in the same sea with the associated Crag Mollusca.[2] He considers the strata to be Older Pliocene, equivalents of the Red Crag and Coralline Crag.

Professor Owen, in his late memoir, enumerates some additions to the Cetacean remains from the Red Crag described in the 'British Fossil Mammalia.' Among these are portions of an upper jaw very closely resembling the *Dioplodon Becanii* of Gervais (*Ziphius* of Cuvier), and 'water-worn teeth corresponding in size and form' with those of the *Hoplocetus crassidens*, an obscure and as yet imperfectly determined form provisionally so named by Gervais,[3] from the Miocene Faluns of La Drôme. Another supposed species of the genus, named *Hoplocetus curvidens* by the same palæontologist, is founded upon specimens procured from the Pliocene sands of Montpellier. The Crag 'Cetotolites' (*i.e.* the same species) have nowhere as yet been described as occurring in Eocene beds in England; and the whole bearing of the evidence would seem to indicate that at least a considerable part, if not the whole, of the 'Red Crag' Cetacea are of the same age as the associated terrestrial Herbivora.

[Since the preceding pages were in type, I have had an opportunity of examining specimens in some of the principal collections in Essex, Suffolk, and Norfolk, which throw light upon some of the points discussed above. In the Town Hall of Colchester there is a fine specimen, comprising both maxillary bones of a young *Elephas* (*Eueleph.*) *antiquus*, and presenting the last milk molar (right side) in place. The matrix is very ferruginous, and the bones and tooth are of a dark-chocolate colour, with a vitreous polish. It was dredged up from off the 'West Rocks' on the Essex coast; and it resembles in its mineral condition the large Cervine horn reputed to be from a Crag pit at Felixstow, and referred by Professor Owen to *Megaceros* (see above, p. 57).

In the rich and valuable collection of Red Crag fossils belonging to William Whincopp, Esq., of Woodridge, there

[1] Oss. Foss. tom. v. p. 352.

[2] Quart. Journ. Geol. Soc. vol. viii. p. 281; and Manual of Geology, 5th edit. p. 174.

[3] Paléont. Franç. tom. i. p. 161. Gervais throws out a suggestion, that his *Hoplocetus* may have a connexion with the *Balænodon* of Professor Owen, but does not enter into a detailed comparison.

are two upper and three lower molars of a species of *Hippotherium* from the Red Crag pits at Sutton. They bear a close resemblance to the Miocene *H. gracile*, Kaup, from Eppelsheim. The same collection contains several molars, upper and lower, of the genus *Rhinoceros*, one of which (an upper antepenultimate milk molar) agrees, in most of the characters, with an original specimen of a corresponding tooth of *Rhinoceros Schleiermacheri* from Eppelsheim, with which it was compared. Mr. Whincopp also possesses an upper maxillary bone containing a series of the molar teeth of *Hyracotherium leporinum*; also detached molars apparently of the smaller species, *Hyrac. cuniculus*, both said to have been procured from the Red Crag at Felixstow. Besides these, Mr. Whincopp possesses: 1st, several perfect Cetacean teeth, resembling those referred to *Hoplocetus* by Gervais; 2ndly, two remarkable molar teeth of a form which has not hitherto been described as a British fossil; and 3rdly, numerous remains of Red Crag *Delphinidæ*.

In the rich collection of Edward Acton, Esq., of Grundisburgh, there are specimens referable to both species of *Hyracotherium*, and reputed to be from Red Crag localities in Suffolk, besides molars of *Tapirus* and *Rhinoceros*. Mr. Acton also possesses a singularly perfect antepenultimate true molar from the lower jaw of *M.* (*Tetralophodon*) *Arvernensis*, showing the peculiar characters of the species strongly marked.[1]

In neither of these collections did I observe any specimen referable to *M.* (*Tetraloph.*) *longirostris* of Eppelsheim, nor to the peculiar Mammalian genera of the Upper Miocene period, enumerated in a preceding paragraph as being usually associated with that species (p. 59). It is manifest that the Hyracotherian remains must have been derived from broken-up Eocene deposits; and the teeth of *Hippotherium* indicate a similar inference of Miocene remains being mixed up with Pliocene forms in the reconstructed materials of the *Red Crag* deposit.—H.F., Oct. 20th, 1857.]

Conclusion.—On a review of the various facts and considerations discussed in the preceding pages, it seems clear that the Mammalian fauna of the Fluvio-marine Crag is of a Pliocene age. The undoubted association of *M.* (*Tetraloph.*) *Arvernensis* and of *E.* (*Loxodon*) *meridionalis* in this deposit admits of no other inference. The mixed contents of the Red Crag, including Mammalian remains of different strata

[1] In Mr. Whincopp's collection there is a very beautiful specimen of an intact germ of an antepenultimate upper milk molar, from the Red Crag, closely resembling the specimens figured by Croizet and Jobert.

from the Eocene period upwards, are inferred to have been deposited in the reconstructed strata also within the Pliocene period, since *M.* (*Tetraloph.*) *Arvernensis*, which occurs so abundantly in the Red Crag, has not been met with anywhere on the Continent of Europe except in deposits of a Pliocene age. The Red Crag sea appears to have breached a previously established and populated Pliocene land, and to have buried the bones referable to various epochs in the same sea-bottom.

In the preceding remarks I have purposely excluded any reference to the *Shell-evidence*, and confined the comparison strictly to the Mammalian Fauna. The Mollusca have unquestionably been wielded as a most powerful exponent of geological chronology, and of the successive physical changes which have taken place on the surface of the earth. But it will hardly be denied that the evidence presented by Mammalian remains, when obtained in sufficient variety and abundance, is of greater significance as a test of contemporaneous formation in geology, or the reverse :—1st, Because Mammalian genera and species are everywhere shown to be of more limited duration in time than the Mollusca; and, 2ndly, because from the vastly greater complexity of their relative functions, they are much more susceptible of being affected by the altered climatal conditions which are necessarily involved in every great physical change, and which conduce most to the extinction of species.

The conclusions to which the comparison has led are :—

1. That the Mastodon remains which have been met with in the 'Fluvio-marine Crag' and 'Red Crag' belong to a Pliocene form, *Mastodon* (*Tetralophodon*) *Arvernensis.*

2. That the Mammalian Fauna of the Fluvio-marine Crag bears all the characters of a Pliocene age, and is identical with the Sub-Apennine Pliocene Fauna of Italy.

3. That the Red and Fluvio-marine Crags, tested by their Mammalian Fauna, must be considered as beds of the same geological age.

APPENDIX TO MEMOIR ON MASTODON.

I.—Note on J. F. Brandt's Memoir on the Skeleton of a Mastodon discovered near Nikolajew (Nicolaieff), in Southern Russia. By Dr. Falconer and Mr. T. Rupert Jones.[1]

Early in 1860 the Imperial Academy of Sciences at St. Petersburg received a notice, with drawings and photograph, of the remains of a large Elephantine animal found in the South of Russia, twelve werst from Nikolajew, to which attention was first called by the army-surgeon, M. Wassilijew. From an examination of the photograph, and from information (from Admiral Butakow) as to the shape of the lower jaw, M. Brandt suggested that the remains may have belonged to *Mastodon angustidens*. 'The portions of the skeletons of Mastodons hitherto found, so far as I know,' says M. Brandt, 'in the Middle and Upper Tertiaries of the various countries of Europe, such as Germany, and here and there in Russia, have been only isolated parts, principally molars, and more rarely fragments of the lower jaw. The Museum of the Academy possesses the half of a lower jaw, furnished with two molars, dug up in the Chersonese Government, near the town of Ananjew. Nordmann and Eichwald have described some molars of Mastodon likewise found in Southern Russia.' M. Brandt recommended the acquisition of the Nikolajew specimen for the Academy.

In June 1860 M. Brandt sent from Nikolajew to the Academy a report of the proceedings of the expedition to that place, entrusted by the Academy to his management. After giving an account of the collections inspected at Moscow, Charkow, and elsewhere, he describes the arrival of himself and scientific companions at Nikolajew on the 31st May, the welcome they received from Admiral von Glasenap, and the cordial cooperation of that gentleman and others in the examination of the bones and in the search for other remains.

The skeleton of the Mastodon had been found in a ravine (formed by spring-floods) about a werst distant from the village of Waskressensk (or Gorochowo), and disappearing on the Ingul, at the place where this river (an affluent of the Bug) makes a bend. The ravine bears at first, from its head, from S. to N., then it takes a NW. direction. In the upper part of the ravine the rocky strata are denuded, and subsequently they disappear with the change of direction, and alluvial soil only is seen at the entrance of the gully.

As early as 1854, after a very rainy season, several large bones had been found here; subsequently the nearly perfect skeleton of the Mastodon was found near the upper part of the ravine, at a depth of 3 'sajen' and 2 'arschin;' the arrangement of the strata being, in descending order, as follows:—

1. Black humus; 9 inches (English).

[1] Reprinted from the 'Quarterly Journal of the Geological Society' for May, 1862.

2. A thin calcareous layer, compact, made up of shell-fragments, 6 inches thick, passing into—

3. A soft grey and white limestone, of oolitic structure, with casts of shells; 5 inches thick.

4. Soft yellowish-grey sand, here and there brownish-red, with oxide of iron, harder beneath, without fossils; 8 inches.

5. Harder sandstone, alternating with beds coloured with oxide of iron, and traversed by layers of clay of various thicknesses, passing downwards into sandy clay with siliceous concretions, but no fossils; 7 feet (English).

In this bed was found the Mastodon; and not far off, in the same stratum, was found a layer of a kind of brown coal, an inch thick. Under this layer a stratum of limestone was observed only a few feet thick; it contained a *Cardium*. Of all these beds the bottom clay and limestone are the only two which are constant. The bones of the Mastodon skeleton that have been saved consist chiefly of the tusks and molars of the upper and lower jaws, the lower jaw, an almost perfect shoulder-blade, nearly all the ribs, a great number of cervical and dorsal vertebræ, and the tolerably perfect bones of the fore foot.

The bones were in a very fragile condition, and their extrication from the firm, moist, loamy earth required great caution. Careful drawings were made of the relative positions of the bones on the spot; and the fragments were carefully numbered, so that it is hoped they will serve to construct, in the Museum of St. Petersburg, a tolerable skeleton, that in its completeness will be one among the best of the preserved specimens of the ancient Mastodons. The bones have already reached St. Petersburg, and have been placed in their proper collocation by the Conservator Radde.

In November, 1860, a supplemental notice, illustrated by drawings, of these remains, was read before the Academy by M. Brandt. The drawings are represented by a large lithographic plate in the 'Bulletin,' and are described at pp. 507–509. All the bones appear more or less displaced, some only slightly; the skull was crushed, and its bones nearly all destroyed by the action of the weather. The back upper molars lay apart from each other. The almost straight tusks, 6 feet 8 inches long, and thickest at the base, were but slightly displaced, although their alveoli had been destroyed, and they themselves broken into many pieces. The tusks of the well-preserved lower jaw were in their natural position, in sockets in a short characteristic symphysial process. The imperfect cervical vertebræ were partly displaced, and, like most of the anterior dorsal vertebræ, were more or less broken or decayed. Only a few of the middle and posterior dorsal vertebræ were tolerably preserved; indeed, but a small proportion of them were found in their natural position. The number of the ribs remaining nearly perfect indicated, as a general rule, that all those which lay obliquely were, for the most part, in a tolerably good state of preservation. The majority of these appeared more or less dislocated, with the exception of the posterior ribs of the left side, which were only slightly displaced. The greater part of the left shoulder-blade was preserved. The right humerus, greatly displaced from its natural position, and lying close upon the vertebral column, is more entire than the left, which is, in connexion with the

bones of the fore arm, crushed outwards. The figures, however, represent only a part, although certainly the chief portion, of the original depôt of the bones of the Woskressensk skeleton,—to wit, those which M. Brandt and his colleagues had been able to observe in their natural position. Before their arrival, several detached bones or fragments were found, lying scattered close to the excavation of the principal remains, and belonging chiefly to the extremities; these fragments were separately preserved, and presented to the Commission on their arrival. Moreover, the lower end of the right scapula had been sent to Odessa, to the Governer-General Count Strogonow, from whom they subsequently received it.

The bones in question are evidently a part of the imperfect remains of the bones of the extremities, which, as stated in the preceding report, had been discovered a few years ago. They lay in a superficial stratum of earth; so that the figured part of the remains, such as the lower portion of the head and the greater part of the trunk, particularly the anterior and middle portions, lay at a lower level, and were covered by a somewhat deeper layer of soil. From this disposition of the remains, it is intelligible how the displacements of the bones and the destruction of the skull took place.

The close study of the remains places it beyond doubt that they belong to an Elephantine form; and further, from the mammillated crowns of the molars as well as the lower jaw, that they are of a *Mastodon*. From the drawings which were in the first instance sent here, says M. Brandt, I was disposed to ascribe them to *Mastodon angustidens*, Cuv., *e.p.* *Mast. angustidens*, Owen (Brit. Foss. Mamm. p. 271), Blainville (Ostéogr. Gravigrades) = *Mastodon arvernensis*, Croizet et Jobert (Ossem. Foss. du Puy de Dôme) = *Mastodon longirostris*, Kaup (Ossem. Foss. de Darmstadt, p. 65) = *Mastodon Cuvieri* Pomel (Bullet. géolog. 1848, p. 257). A closer but in nowise satisfactory study of the involved and tangled synonymy of the Mastodons led me, however, to abandon the earlier opinion formed from the drawings, in consequence of the different form of the crowns of the molars, as also the exceedingly short, straight symphysial process of the lower jaw. *Mastodon angustidens*, Cuv. (*magna e.p.*), Owen (= *Mastodon longirostris*, Kaup), possesses a very prolonged and deflected symphysial process, half as long as the entire length of the lower jaw, with moderately stout tusks, while the crowns of the molars are characterized by the circumstance of constantly presenting in the unworn state a small and accessory outlying tubercle, interposed between each pair of the strongly compressed principal tubercles on their broader surfaces.

In contrast to the characters just indicated of *Mastodon angustidens*, which would be considered identical with *M. longirostris*, it may be said that in the Nikolajew remains the symphysial process, together with the straight tusks, does not attain a quarter the length of the lower jaw. The broad surfaces of the crown tubercles of the molars are but slightly folded, and have no accessory tubercles between them. The upper and elongated tusks are quite straight.

With reference to their form resembling that of the Tapir, the molars of our skeleton agree best with those of the *Mastodon Tapiroïdes*, Cuv., figured by De Blainville (Ostéog. Gravigrades, Pl. XVII.).

The Nikolajew skeleton may therefore be referred, on the best grounds, at any rate provisionally, to *Mastodon Tapiroides*. The remains in question thus determined, since they cannot well be referred to *Mastodon longirostris*, would appear to possess a positive scientific value, and are calculated to establish on more definite grounds a species hitherto accepted only from the characteristic form of the molars. At the same time they demonstrate that, at least in Europe and Russia, another species of the genus *Mastodon* existed, besides *Mastodon longirostris*.

The significant fact referred to in the preceding report is worthy of attention, viz. that a few steps from the site of the Mastodon remains, and in one and the same deposit, there was found a layer, about an inch thick, of a rusty, incompact wood, approaching the condition of lignite. The origin of it can only be explained thus, that the place where the remains were found bore forests during the period of existence of the Mastodon, whilst at the present time its surface presents bare tracts of steppes or prairie-land. From what we know of the habits of the existing Elephants, it may also be reasonably inferred that the wood in question constitutes a part of the remains of arboreal forms, the young twigs and leaves of which furnished at least a part of the food of the Mastodons. We may lay the greater stress on this view, as the remains of our Mastodon, which were tolerably connected with each other, or at any rate not very far separated, belonged to an individual that died at no very great distance from the place where they were found. [H. F. & T. R. J.]

NOTE.—The Nicolaieff *Mastodon*, as above indicated by Professor Brandt, appears to belong to *M. Tapiroides*; but, as De Blainville, to whose figures the author refers, confounded two distinct species under this name, viz. *M. Borsoni* and *M. Tapiroides*, the former a Pliocene form, and the latter from the Middle Miocene deposits of France and Switzerland, it is important to add, that the Nicolaieff skeleton belongs, so far as a determination can be rested on the figures, to the *M. Tapiroides* proper of the French palæontologists, being the *M. Turicensis* of Schinz, from the lignite beds of Kœpfnach. See Schinz, Schweitz. Denkschr. vol. vii. p. 58, Pl. I. fig. 1; De Blainville, Ostéographie, Gen. Éléph. Pl. XVII. sup. 5 & 6[e], infer. 1 & 6[a]; Lartet, Bulletin Soc. Géol. de France, vol. xvi. p. 486, Pl. XV. fig. 3.—H. F.

II.—EXTRACTS FROM DR. FALCONER'S NOTE-BOOKS.

A. MASTODON ANGUSTIDENS AND M. BORSONI.

Zurich Museum, August 29, 1856.

Returned here from Basle this morning, to examine the Proboscideans fossils from Kœpfnach, &c.

Examined: 1st. The tooth figured by Schinz, Tab. I. fig. 6, being the penultimate upper right of *Mast. angustidens* found in Kœpfnach. It is of a very broad oblong shape, with three ridges and intermediate mammillæ interrupting the continuity of the valleys. The large mammillæ are very blunt and converging, as in *Mast. angustidens*. The enamel is very smooth; the posterior talon descends outwards from the last inner tubercle, and is crenulated with a number of

minute mammillæ, as in Schinz's figures. It is from the lignite of Kœpfnach, and is black.

Length of crown, 4·4 in. Width of crown, 1st. ridge, 2·7 in. Width of crown, 2nd ridge, 3·1 in. Width of crown, last ridge, 2·9 in. Height of crown (about) 1·7 in.

The internal basal bourrelet is very strongly developed.

2nd. Examined the original of the lower jaw, young specimen from Buchberg, which is exceedingly interesting from showing the germ of a vertical *dent de remplacement* in front of the worn 3rd milk molar. It is of the right side, showing the horizontal ramus nearly entire, (except at the posterior angle), and the ascending ramus. The leafy expansion is exhibited, but the condyle and coronoid are broken off. Two exserted teeth are seen in the horizontal ramus, and one behind; an included germ is disclosed by a lateral breach of the alveolar cavity on the inner side.

The posterior protruded molar is the third milk molar, of which the greater part of the crown is broken off, showing only the anterior ridge, nearly entire, and the posterior talon intact. The anterior ridge is only slightly touched by wear. It shows a very marked anterior disc of pressure, and the accessory mammillæ behind interrupting the valley.

Length of crown, 2·8 in. Width of crown at 1st ridge, 1·4 in.

Of the penultimate milk molar a small portion remains posteriorly, the great mass of it having been extruded by the germ of the corresponding vertical successional premolar, which is seen considerably protruding, but much below the level of the 3rd milk molar, and quite intact and in germ, indicating its nature; only the last ridge remains, showing complex converging minute mammillæ, very different from the transverse character of the ridges of *Mast. Tapiroides*. The cast of the shell remains, indicating a length, including fang, of about 2 inches, by a width of about 1·2 inches.

Behind the 3rd milk molar is seen the shell of the 1st or antepenultimate true molar, showing three ridges and a heel, but not sufficiently disclosed for description, except that the inner tubercle of each ridge is blunt and rounded (the *M. angustidens* character), and not trenchant.

The anterior part of the jaw is broken off, giving no hint as to the form of the symphysis.

3rd. Examined also a superb undescribed specimen of the penultimate and last molars of the lower jaw left side, of the same species, adhering together, but retaining no portion of the jaw. The anterior tooth is well worn on the three ridges, but the anterior ridge only has its points worn down into one common disc. The discs are simple in their outline, and very much like those of figs. 9 and 9 *a* of *M. angustidens* in Plate XL. of the 'Fauna Antiqua Sival.,' but less touched by wear. The greatest difference is in the talon (posterior) which has one large point with numerous crenulated points forming a small transverse ridge. The intermediate mammillæ are exactly as in fig. 9 *a* of the 'Fauna Antiq. Sival.'; there is no basal ridge. The tooth in form of crown is less cucumber-shaped than usual.

Length of crown, 4·8 in. With at 1st ridge, 2·35 in. Width at 2nd ridge, 2·75 in. Width at 3rd ridge, 3· in.

The lateral outline of the crown, seen from above, forms salient projections, and re-entering hollows causing constrictions.

Constriction at base between 1st and 2nd ridges, 2·3 in. Constriction between 2nd and 3rd ridges, 2·5 in.

The last true molar is in germ, and shows only the two anterior ridges, the posterior half being broken off. The points are very high and convergent, the outermost on either side the largest. The bridge connecting the 1st and 2nd ridges, across the valley, consists of numerous minute mammillæ, chiefly connected with the posterior surface of the 1st ridge.

4th. The tooth, fig. 7 of Schinz's Plate I., shows nearly a square crown, with four discs of wear, indicating four points. It is of the right side, and appears to be the 2nd milk molar upper right, as it bears a well marked impression of disc of pressure, both in front and behind, showing that it had acted on a tooth in front, and had also been pushed from behind. It has a well marked basal bourrelet.

Length of crown (about) 1·5 in. Width of crown (about) 1·45 in.

Although worn there is very little difference of level between the enamel and ivory of the disc depressions.

Schinz's figure is tolerably good. The tooth is described by him as being from Elgg; but this is denied by himself on inquiry, and also denied by Mons. Escher de la Linth. It is stated to be from Kœpfnach.

5th. Examined also a beautiful little detached germ-tooth, corresponding very closely with Schinz's fig. 8, with a complex oval converging crown. It is intact, and as it bears no disc of pressure either in front or behind, although the fangs are well developed, I regard it as the upper vertical successional premolar, which pushed out the second above. But it is very much smaller than the ascertained premolar of the lower jaw, and may therefore be the first milk molar upper jaw. The fangs are double and well developed. It is from Kœpfnach.

Length of crown, 1·3 in. Width of crown about 1· in.

I have not been able to find the specimen fig. 3 of Schinz, described by him as an 'Elgg Mastodon.'

6th. Examined also two superb fragments of the extremity of the tusk of a Mastodon from Kœpfnach.

One of these measures 18 inches in length. It is remarkable in two respects: 1st, that the upper concave side is gradually compressed into a trenchant edge, the transverse section being pyriform; 2nd, that, when the outer layer is removed, the surface below shows the grooves of broad channelling, noticed by Cuvier, and figured by Schinz. The grooving is especially shown on a flattened surface, near the point on one side.

Length about 18· in. Depth at thick end, 4·2 in. Width, 2·8 in.

The upper edge is so sharpened off as to be like a keel to the concave side. I have seen nothing like it in any other Mastodon. The ivory is as black as the lignite, and so light and altered that it seldom shows the *guilloché*, or engine-turning. I could not make out that there is enamel, but it may be there. Some other fragments nearer the base are oval in section, and not pyriform.

Vertical diameter, 4·7 in. Transverse diameter, 3·7 in.[1]

[1] *Extract from letter to M. Lartet, dated Sept.* 30, 1856:—

'In the hurried note which I sent you from Toulouse I forgot to mention that

In those fragments there are broad shallow channels.

7th. *Mastodon Borsoni*. Second species of Swiss Molasse Mastodon. A superb, conglomerated, lignite specimen, containing three teeth *in situ*, but dislocated, and judged to be of the upper jaw, right side. I will describe the teeth from behind forwards, in the order of their completeness.

These molars are at once distinguished, all of them, from the *Mastodon angustidens* specimens, by the ridges being transverse, elevated, and trenchant, without intermediate mammillæ interrupting the valleys, and by their general similitude to *Mast. Ohioticus*.

The last tooth is in germ, and partly embedded on the inner side in the alveolus, concealing the bourrelet. It is the penultimate or second true molar, showing three transverse ridges intact. A mesial line of longitudinal bipartition is seen. The points on the inner side are the largest, and the inner division of the two front ridges consists chiefly of this point. The posterior mesial surface of the front ridge sends down a vertical keel as in the specimen of *M. Borsoni* at Turin. The anterior talon is a transverse basal bourrelet, connected with the front inner point by a vertical ridge. The bourrelet is continued around the base on the inner side, but is partly concealed. The posterior talon is an insignificant basal bourrelet, very little developed. The three ridges are nearly of the same height and width, the crown being ob

Length of the tooth, 3·5 in. Width, at 1st ridge, 2·2 in. Width, 2nd ridge, 2·45 in. Width, 3rd ridge, 2·15 in. Height of crown (shell), 1·75 in.

It agrees very nearly with the cast-measurement taken at Geneva, and is evidently the same tooth.

The next tooth in front is the 1st true molar (for reasons connected with the next to be described). The posterior ridge and the inner half of the middle ridge are broken off, giving no measurements. The anterior ridge is entire and very slightly affected at the edge by wear, trenchant as in *M. Ohioticus*, with a very pronounced basal bourrelet, which is continued in front transversely in a basal slightly developed talon. There is no interruption of the valley.

Length of crown about 3·1 in. Width of 1st ridge, including bourrelet, 1·9 in. Width of 2nd ridge, including bourrelet, 2·3 in. Width of 3rd ridge, about 2·4 in.

The cast-specimen at Paris shows that this cannot be the third milk molar.

Immediately in front of the first true molar, but dislocated to the inside of it, is an entire germ of a square tooth, with two transverse

Mons. L. showed me several fragments of a well-preserved tusk of compact texture and very hard, very different from anything I saw with you at Seissan. The section is round or oval, but has no tendency to be pyriform. The original surface is well preserved with a kind of cortical outer layer, in some parts a good deal *sillonė* transversely with fine wavy lines and no appearance of enamel (probably the alveolar portion). It was found, if I remember rightly, where *Mastodon Tapiroïdes* and *Dinotherium* are found. The fragments do not fit together, but the tusk seemed to be concave at the point and a good deal curved. This specimen has made me feel uncomfortable about my inferences respecting the *M. Tapiroïdes* origin of the tusk specimens I saw at Zurich. There is not the least appearance when the cortical layer is removed, of the *sillons longitudinales*. Can it be the incisor of *Dinotherium*?'—[ED.]

trenchant ridges, a basal inner bourrelet, and a front and back talon developed like the bourrelet. Each ridge consists of about six points. This is evidently the vertical premolar succeeding the last milk molar, as it shows no disc of pressure either in front or behind.

Length of crown including talons, 1·8 in. Width of crown at front ridge, 1·3 in. Width at second ridge, 1·5 in.

The tooth is partly embedded; the width of the trenchant edges is nearly as great as of the base.

In front of this there is an obscure appearance of another minutely cusped tooth, probably another premolar! in which case it would be the successor of the second milk molar. But the mass is too conglomerated to make this certain. There had evidently been a tusk along the side which has left its grooved impression.

8th. Another beautiful small conglomerated fragment consists of: 1st, a portion of grooved tusk distinctly showing *guilloché*; 2nd, a square two-ridged tooth exactly the counterpart of the last, and also in germ; and 3rd, a small two-fanged oval crowned complex germ tooth, exactly like that described as being the vertical premolar of *Mast. angustidens*; but dislocated and at right angles to the other tooth.

Length of two-ridged tooth, 1·8 in. Width at front ridge, 1·4 in. Width at back ridge, 1·55 in.

In every respect, in size, in form of ridges (which are not parallel in either), it is exactly like the other, and probably of the opposite side.

The small tooth in the first specimen would therefore seem not to be of *Mast. angustidens*, but of *M. Borsoni*.

The grooved tusks would also seem to be of this species.

All these fragments are marked on the labels as being from Elgg, but this is denied by Mons. Escher.

9th. Examined a beautiful germ-specimen of the penultimate of lower jaw, left side, with a disc of pressure in front, but quite unworn. The ridges very trenchant; a vertical keel to the inner tubercle of front ridge; the ridges sloping a little backwards and outwards. No interruption to valleys; outer and inner points most elevated; middle points concave; posterior talon transverse, consisting of small crenulated points; anterior talon very little developed; no basal bourrelet; and no constriction as in *Mast. angustidens*.

Length of crown, 4·1 in. Width at 1st ridge, 2·25 in Width at 2nd ridge, 2·55 in. Width at 3rd ridge, 2·75 in.

I infer this to be the penultimate of *Mastodon Borsoni*, but the position is not absolutely determined.

In all these specimens, a little connecting keel descends from the anterior and posterior sides into the valleys without in the least interrupting them; from the inner points (outer Lartet) of the upper teeth, and outer points (inner) of the lower; being a very reduced condition of the bridge seen in Kaup's *Mastodon longirostris*; it is very minutely crenulated, forming a keel. There is also a marginal crest to the *outer* of upper, and *inner* of lower, but less marginal in the upper.

10th. Another specimen, containing the third milk molar (anterior ridge broken off) of the lower jaw, presents the same characters. It has

also the first true molar behind it, the crown being entirely broken off, but shown to be in germ. A portion of a grooved tusk is attached. If of the lower jaw, it would be of left side. It corresponds very much in size with the upper third molar above described in the principal conglomerated specimen; the vertical ridge is very well marked.

Width of 1st ridge, about 2·2 in. Length of crown, about 3·3 in.

The ridges are trenchant, and made up of about six points; valleys perfectly open; the posterior talon has a crenulated bourrelet, as in the small second milk upper of *Mastodon latidens*, but much less developed. The two posterior ridges are very little touched by wear.

B. Mastodon Angustidens.

Winterthur, August 30, 1856.—Museum of Mons. Johann Ziegler-Ernst.

Got a note from Professor Heer, and visited M. Ziegler, who showed me a superb specimen of the lower jaw, both sides nearly complete (but broken up, the left side especially, into several fragments, which fit together, and also to a large block of sandstone matrix), of a half grown or younger individual of *Mastodon angustidens.* It exhibits the milk-dentition, also one of the vertical premolars, both sides, and a true molar embedded in the alveolus; also a considerable portion of the prolonged beak, which shows the transverse section of two very compressed lower incisors.

The following teeth are seen in succession:

A.—An oval shaped bicuspid tooth with an entire crown, but chiefly concealed in matrix, so that the top of it cannot be seen, only the side. It resembles in form very much the small cuspid tooth seen in the Museum at Zurich. By the section it is seen to have two compressed fangs. The larger cusp is in front, the smaller behind; but both are partly concealed by matrix.

The crown measures 1·2 inches in length. The posterior edge of the anterior cusp is vertically lobed by three indentations. The crown would appear to be quite entire and unworn.

B.—A tooth of which the crown is entirely concealed in matrix, but the side of the basal enamel is disclosed, and also the broken ivory nucleus. This tooth presents two large and separated fangs: the posterior being much the largest. Judging from the length, one would almost suppose that it had three ridges; but this is unfortunately concealed by matrix, nor is it visible what amount of wear it had undergone; it is assuredly a milk molar, from there being a vertical premolar below it.

Length of crown enamel, 2·4 in.

C.—Immediately below this tooth and pushing it up is seen the germ of a vertical premolar of large size (so to speak), exactly as in Lartet's specimens in the Paris Museum.

Length of this tooth so far as disclosed, 1·4 in. Height of anterior cusp, 1·1 in.

D.—Immediately behind the tooth B is placed another molar (with three ridges), of which on the left side the top of the crown is seen, but the two anterior ridges are broken off. The posterior ridge and the talon are quite entire. The last ridge has the tips of the tubercles just

abraded into little round discs, showing that it had been in wear, and that the anterior ridges must have been worn. The talon is of two points, exactly as in Plate XL. fig. 7, of the 'Fauna Antiqua Sivalensis.' The tubercles of the last ridge are 4 or 5; the outer and inner are very blunt. The intermediate mammillæ are not shown.

Extreme length right lower jaw from beak to posterior edge of ascending ramus, 23· in. Length of beak from broken tip of incisives to posterior curve of symphysis, 6·4 in. Height of jaw below the 1st small molar, 3·15 in. Width of jaw below (about) 1·8 in. Length of crown, 2·75 in. Width at base of last ridge, 1·75 in.

This tooth I infer to be the third milk molar evidently of *M. angustidens*, but there is certainly no premolar below it. It must be added, however, that the fangs press down into the dentary canal leaving no room. Taking into account the great length of the crown of the tooth B, which could have three ridges, is it possible that that tooth is the third or last milk molar, and this one the first true molar? This matter must be well weighed. (See *antea*, p. 39, note 1.)

The vertical height of the corresponding tooth is well seen on the right side entire, and of three ridges; but the top of the crown is not shown. The length is estimated to be about 2·8 in. to 2·85 in.

E.—Behind the tooth D, on the right side, but embedded in the posterior part of the alveolar cavity in the angle of the ascending ramus, is seen the enamel-shell of a germ which shows three ridges. The side of it only is seen, and imperfectly, without the talons. The visible part of the three ridges measures in length about three inches; it is therefore a small tooth, and probably the first true molar. On the left side a transverse section view is had of one of the ridges, giving a width of only 1·7 in. to the crown. This ridge is seen to consist only of four distinct obtuse tubercles in two pairs; the outermost is the largest, with the well-marked form of *M. angustidens*.

The left incisive gives a vertical section of about 1·1 in.

It is very much compressed with a sort of reniform groove to the inner side. The surface is very much channelled superficially.

The anterior part of the lower jaw is very narrow and compressed, as in the Paris specimen. It was discovered last year (1855) in a sandstone quarry about a mile from Winterthur, at a place called Veltheim Quarry, embedded in a fine grained greyish sandstone, nearly horizontal, being the Upper Molasse. The matrix is exactly like the tunnel specimen at Zurich.

Found fragment also of what I believe to be the upper tusks, superficially channelled:

Transverse ? diameter, 1·0 in. Vertical ? or smaller, 0·6 in.

C. Mastodon from America.

Extract of Letter from Dr. Falconer to M. Lartet, September 12, 1856.

'At Genoa I saw a cast of a large lower jaw of a Mastodon from Mexico, with an enormous *bec* abruptly deflected downwards and containing one very large lower incisor. The beak is much thicker than in *M.* (*Trilophodon*) *angustidens* and larger than in *M.* (*Tetralophodon*) *longirostris*. You know that every one (Laurillard, Gervais, &c.) has insisted on the absence of the lower incisors from both of the South

American species. The outline of the jaw resembles very much the figure in Alcide D'Orbigny's Voyage, described by Laurillard as *M. Andium*. The specimen is unpublished material, and I was therefore only allowed to examine it very cursorily. The Genoese palæontologists had provisionally named it *Rhynchotherium*, from the enormous development of the beak, approaching Dinotherium.'

II. ON THE SPECIES OF MASTODON AND ELEPHANT OCCURRING IN THE FOSSIL STATE IN GREAT BRITAIN.

PART II. ELEPHANT.[1]

I. INTRODUCTION—II. SUBGENERA OF ELEPHAS—III. CHARACTERS OF STEGODONS:—1. ELEPHAS (STEG.) CLIFTII—2. ELEPHAS (STEG.) INSIGNIS IV. PENTALOPHODON—V. CHARACTERS OF LOXODONS:—1. AFRICAN ELEPHANT—2. ELEPHAS (LOX.) PLANIFRONS—3. ELEPHAS (LOX.) PRISCUS —4. ELEPHAS (LOX.) MERIDIONALIS—A. TUSCAN SPECIMENS—B. BRITISH SPECIMENS—VI. CHARACTERS OF EUELEPHAS:— 1. INDIAN ELEPHANT— 2. ELEPHAS (EUEL.) PRIMIGENIUS—3. ELEPHAS (EUEL.) ANTIQUUS— VII. GEOLOGICAL AGE OF ELEPHANTS.

In the remarks introductory to the preceding part of this essay I adverted to the importance, for sound reasoning in geology, that every Mammal found in the fossil state should be determined specifically with precision, and I endeavoured to illustrate the point by the entanglement and confusion of the Faunas of the Miocene and Pliocene periods, which had arisen from so many distinct forms of different ages having been ranged by Cuvier and later palæontologists under the common name of *Mastodon angustidens*.

[1] This memoir was communicated to the Geological Society of London on June 3, 1857, and an abstract of it was published in the 'Quart. Jour. Geol. Soc.,' vol. xiv. p. 81. The publication of the paper, *in extenso*, was postponed in order that the author might incorporate the results of further investigations, and, unfortunately, this had not been effected at the time of his death in January 1865. In August 1865, the memoir was published in a very imperfect form in the 'Quarterly Journal of the Geological Society,' the entire description of *Elephas antiquus*, &c., portion of that *Elephas primigenius*, together with all the general conclusions, being wanting. The description of *E. antiquus* and a portion of that of *E. primigenius* appear never to have been written; but an attempt has now been made to remedy these omissions by extracts from Dr. F.'s Note-Books. The manuscript of the concluding portions of the paper, which treats of the bearing of the fossil elephants, regarded as distinct species upon the classification of the newer tertiary strata, was discovered among Dr. F.'s papers, subsequently to the appearance of the first part of the paper in August 1865, and is now for the first time published. The illustrations have been obtained from the 'Fauna Antiqua Sivalensis,' and from the sources specified in each case.—[Ed.]

The observation applies with still greater force to the case of *Elephas primigenius*, to which a scope in space and time, taken together, has been assigned, without a parallel, I believe, within the whole range of the Mammalia, fossil or recent. D'Archiac, in his excellent 'Histoire des Progrès,' so late as 1848, gives a brief summary of the localities in which the remains of the 'Mammoth (*E. primigenius*) have been said to occur, namely, from the British Isles across the whole of the temperate zone of Europe and of Asia, and along all the coasts and islands of the Icy Sea, as far as the frozen cliffs of the east coast of Behring's Strait; in Eschscholtz Bay; in Russian America as high as 66° of N. lat.; over most of the United States of North America; in the great valley of the Mississippi; and along the coasts of the Gulf of Mexico.'[1] Struck with the extent of this vast area, including all the emerged lands between the parallels of 40° and 75° N. lat., he puts a query whether the Elephantine remains met with by Humboldt on the plateau of Quito and at Cumanacoa, in Columbia, did not also belong to the same species.[2] De Blainville, going a step beyond most other palæontologists, doubtingly referred the fossil remains of Elephants found so abundantly in tropical India to the same species,[3] thus assigning at least half of the habitable globe for the pasture ground of the Mammoth.

The duration allotted to the same species is equally remarkable. Discovered fresh, either in the frozen cliffs or in ice-blocks at the mouth of the Lena, it has been traced, through its osseous remains, in the superficial gravel-beds over nearly the whole of northern and the greater part of central Europe. Here it has consistently been found in company with the Siberian Rhinoceros (*R. antiquitatis*, Blum.), the Musk-ox, and the Reindeer. The same specific form has been carried down into the so-called 'Pleistocene' clay, loam, and mud deposits which are so massively developed on the Norfolk and Suffolk coast, in company with *R. leptorhinus*, *Hippopotamus major*, and other extinct forms; thence through the submerged forest and lignite bed of Happisburgh and Mundesley into the Crag in company with *Mastodon* (*Tetralophodon*) *Arvernensis*; and abroad into the 'Older Pliocene' beds of the Sub-Apennines, and of Monte

[1] Bronn enumerates the following localities: Spain, Apulia, and Sicily; the Islet of Gozo near Malta, Athens, and Odessa; the whole of Europe except Scandinavia; from the Caucasus, through the whole of Siberia, north to the Polar Sea, and Kamtschatka; on the north-west coast of America, as far as Eschscholtz Bay; on the east side of North America, in Ohio, Kentucky, and South Carolina, including the parallels between 40° and 75° N. lat. (Lethæa Geognostica, Band iii. p. 819.)

[2] *Op cit.* tom. ii. p. 378.

[3] Ostéographie: 'Des Éléphants, p. 222.

Mario, Monte Verbo, and other localities in the south of Italy. The measure of time involved in the thus implied duration of the species is best appreciated by considering some of the changes that appear to have taken place in Europe during the interval. The Alps, the Pyrenees, and the Apennines have all undergone a considerable amount of elevation. When the earliest Elephants were roaming over the emerged land of Italy, a wide and open sea communication would seem to have existed between the Mediterranean and the Atlantic Ocean, admitting of a common province for the Mollusca of the shores of the Crag-sea and of Italy, and a common resort for the Whales and Dolphins which abounded at that period in European waters. Portions of the Pliocene sea-bottom of the Sub-Apennines, consisting of stratified beds full of marine shells, and containing nearly entire skeletons of Elephants and Rhinoceros, have been thrown up into hills, which, after a long series of ages of degradation, still maintain an elevation of 1,700 feet above the level of the adjoining sea. Yet, if we are to accept the confidently expressed opinion of Cuvier, long after his early inferences had been questioned, the same form of Mammoth lived through all these mighty changes, and it is only yesterday as it were, in relation to the human epoch, that its last remnant was exterminated and frozen up in the perennial ice-cliffs of the Arctic Circle.

It will hardly be denied by any one who attempts to reconcile the English and Continental classifications, that the arrangement of the newer Tertiary and Glacial deposits in successive chronological order is at present in a very unsatisfactory state, probably more so than that of any part of the older Tertiary series; and it appears to me that nothing has contributed more to retard the progress of this section of geology in Britain than the generally accepted belief in the specific unity of the Mammoth, wherever fossil remains of Elephants were discovered in European strata. The percentage of extinct Mollusca, so valuable a guide in the identification of the middle Tertiaries, becomes in the newer Tertiaries an evanescent quantity—at every step more elusive as we ascend upwards; and if the geologist tried to extract some help from the associated Mammalian remains, he was at once perplexed by the ubiquitous presence of the Mammoth. The very name of *Elephas primigenius* was suggestive of 'transported gravel,' 'diluvial action,' 'glacial drift,' or some other explanation suggested by the image of the Woolly Mammoth, frozen in, flesh and bone, at the mouth of the Lena; so that every stratum in which Elephant bones were met with was regarded in some degree

under the influence of a foregone conclusion. Numerous instances might be cited of the force of this bias upon the views of some of the ablest writers on the geology of the later Tertiary deposits.

The object of the present communication is to show that several European fossil species, belonging to two distinct subgenera, have been generally confounded under the name of *Elephas primigenius*, that these species are susceptible of being discriminated, not on mere trivial or uncertain, but upon broad and well-founded distinctions, and that their range in time is consonant with what is known of other well-determined species of Mammalia, namely, that they have been restricted within definite eras. In order to give any weight to the specific distinctions among the fossil Elephants which I shall endeavour to point out, it will be necessary to explain the grounds upon which they are founded in greater detail than is set forth in the remarks introductory to the preceding part of this essay, when treating specially of the Mastodons; and, at the risk of being chargeable in some measure with repetition, I must solicit the indulgence of the Society on the subject.

The specific name of *Elephas primigenius*, adopted from the eminent German naturalist, Blumenbach, was applied by Cuvier to all the fossil Elephantine remains occurring in Europe, Northern Asia, and America, up to the date of his last edition of the 'Ossemens Fossiles.' De Blainville, swayed by his adherence to the dogma of a *single* and simultaneous creation of living beings, subject to incessant extinctions, but never repeated, in admitting *Elephas primigenius*, extended its area for the reception of the living Indian Elephant, as he held the opinion that there were not sufficient grounds for regarding them as specifically distinct.[1] Owen adopted Cuvier's limitation of the Mammoth; but, struck with the wide differences presented by molars from various British strata, he endeavoured to account for them on the hypothesis of a gradation between thick and thin plated varieties.[2] Gervais,[3] while fully admitting the *a priori* im-

[1] 'En sorte que le résultat définitif auquel on est conduit par une logique rigoureuse, c'est que dans l'état actuel de nos collections du moins au Muséum de Paris, il est encore à peu près impossible de démontrer que l'Éléphant fossile, dont on trouve tant de débris dans la terre, diffère spécifiquement de l'Éléphant de l'Inde encore vivant aujourd'hui,'— De Blainville, 'Ostéographie: Des Éléphants,' p. 222.

[2] 'If these varities' (*i.e.* thick- and thin-plated) 'actually belonged to distinct species of Mammoth, those species must have merged into one another, so far as the character of the grinding teeth is concerned, to a degree to which the two existing species of Elephant, the Indian and African, when compared together, offer no analogy.'

[3] Paléontologie Française (1848–52), p. 35.

probability that the same species of Elephant ranged from the Pliocene up, through the Pleistocene, to the Post-Pliocene period, adheres to the specific unity of *Elephas primigenius*; and he endeavours to escape from the difficulty by assuming that the so-called Pliocene remains of Elephants have been wrongly determined, and ought to be referred to the genus *Mastodon*. To avoid cumbering the present communication by a tedious citation of other authorities, I may refer to the two latest compilations on palæontology, respectively by Bronn and Pictet, for the existing state of knowledge and opinion upon the subject. Bronn, after an exhaustive exposition of the literature on fossil Elephants, sums up by stating that the number of fossil species, exclusive of two or three Indian forms and of *E. priscus* (upon which he does not venture to decide), is limited to a single, or, at the utmost, two fossil species; and he ranges all the European forms, with the exception of *E. priscus*, under the synonymy of *E. primigenius*.[1] Pictet doubts the veritable fossil nature of the specimens upon which *E. priscus* was founded; the other nominal species he considers as not established on sufficient grounds, and he would continue them all, inclusive of *E. meridionalis*, under the common designation of *E. primigenius*. He questions the occurrence of Elephant remains in the Pliocene period, leaning to the opinion of Gervais, that the asserted instances should be referred to the genus *Mastodon*.[2]

The restriction of the European fossil Elephants to a single species was first called in question by Nesti, as far back as 1808, upon fossil remains discovered in the Val d'Arno, for which he proposed two new designations.[3] Nesti was in possession of the most ample materials for the establishment of one of these, *E. meridionalis*; but, unfortunately for science, he described the lower jaw of *Mastodon* (*Tetralophodon*) *Arvernensis* as that of an Elephant, and abandoned the characters furnished by the molar teeth as untrustworthy and uncertain; and his *Elephas meridionalis* and *E. minutus* succumbed to a criticism by Cuvier. The former was revived by Croizet and Jobert in 1828, for remains found in the Velay[4] under the name of *Éléphant de Malbattu*; it has been

[1] 'Die Anzahl der fossilen Arten mag sich, ausser 2 bis 3 *ostindischen* am Fusse des *Himalayah* gefunden, und abgesehen von *E. priscus*, uber den wir nicht entscheiden wollen, auf eine bis höchstens zwei beschranken, womit auch die *americanische* dickplattige Form, *E. Americanus*, Leidy, ubereinzustimmen scheint.' — Bronn, Lethæa geognost. (1856) edit. 3, Band iii. p. 814.

[2] Pictet, Paléontologie, 1853, tom. i. p. 284.

[3] Annali del Museo di Firenze, tom. i. 'Di alcune ossa fossili de' Mammiferi che s' incontrano nel Val d' Arno.'

[4] Oss. Foss. du Puy-de-Dôme, pp. 123–132.

admitted by Christol[1] and Pomel[2] for others from Auvergne and Montpellier; and by Morren, in his account of the Elephant remains occurring in the fossil state in Belgium.[3] In 1847 it was applied, in the 'Fauna Antiqua Sivalensis,' to remains from the Norwich Crag and lignite bed.

Goldfuss, in 1821, proposed the name of *Elephas priscus* for some supposed fossil molar teeth, bearing a strong resemblance to the molars of the existing African Elephant. Cuvier disputed their authenticity as real fossils; and it is not a little curious that Goldfuss would appear in this case to have founded a veritable species upon spurious materials. I detected in the British Museum molars of indubitable fossil origin from the brick-earth deposit of Gray's Thurrock, in the valley of the Thames, presenting characters closely resembling Goldfuss's species, and figures of them were published[4] under the name of *E. priscus* in 1847. Pomel applies the name to some fossil molars described by Laizer in Auvergne.

Fischer de Waldheim, Eichwald, and Morren together have proposed eight nominal species as distinct from *E. primigenius*; but these were based, for the most part, on such obviously trivial characters that discredit was reflected on the species which had a better foundation.

In 1847 I proposed the name of *E. antiquus* for molars which are met with in vast abundance in certain of the newer Tertiary beds in England, and in corresponding deposits on the Continent, more especially in Italy; but no descriptions having accompanied the published figures, the species has hardly been noticed, and nowhere admitted, by other palæontologists.

II.—The Subgenera of Elephas.

In the first part of this essay (page 11) it was attempted to be shown that the species of *Mastodon*, with the single exception of *M. Sivalensis*, are susceptible of being arranged in two natural groups, *Trilophodon* and *Tetralophodon*, according to a definite and isomerous numerical expression of the crown-ridges of the three 'intermediate molars' of both jaws, and that this formula implies the ridge-characters of the other molar teeth.

In the Elephants, the divisions of the crowns of any one

[1] Ann. des Sci. Nat. 1835, 2[me] sér. Zool. tom. iv. p. 197.

[2] Catal. Méthod. et Descript. 1854, p. 74.

[3] Mémoire sur les Ossemens fossiles d'Éléphans trouvés en Belgique, 1834, p. 13.

[4] Fauna Antiqua Sivalensis, Pl. xiv. figs. 6 & 7. (See vol. i. p. 441.—Ed.)

of the 'intermediate molars' are never less than six; and in the species, fossil and recent, that are furthest removed from *Mastodon* in affinity, they range as high as 16 or 18 in the penultimate true molar, or third of the 'intermediate' series. They are not isomerous, as in the Mastodons, but deviate from the numerical symmetry either by an augmentation of one ridge to the crown of the last 'intermediate molar,' constituting the *hypisomerous* forms, or they are more numerous, and augment by progressive increments corresponding with the increase of age, including the *anisomerous* forms.

The Elephants with hypisomerous-ridged molars are divisible into the two natural groups, *Stegodon* and *Loxodon*; the *anisomerous* species form a third natural group, for which, as already explained, the term *Euelephas* is proposed.

III.—Characters of the Stegodons.

1. *General Remarks.*—The Stegodons form the nearest approach in natural affinity to the Mastodons, and more especially to that subdivision of the section *Tetralophodon* which comprises *M.* (*Tetraloph.*) *longirostris* and *M.* (*Tetraloph.*) *latidens*. This is evinced by the low elevation and transverse direction of the crown-ridges, by their nearly uniform height throughout the length of the crown, by their thick enamel, and by the mammillary form of the ridge-processes. A fragment of one of these teeth, denuded of its coat of cement, and seen by a naturalist for the first time, would at once be referred to *Mastodon* rather than to *Elephas*; and it was this broad resemblance which struck Clift so forcibly that he applied to them the designation, at the time very appropriate, of *Mastodon Elephantoides*. But when the essential characters are analyzed, the species are seen to partake more of the nature of true Elephants:—

1st. In the greater number of the crown-ridges and of the mammillæ or points that enter into the composition of each. 2nd. In the agreement of the 'ridge-formula' of certain of the species with that of the existing African Elephant and other Loxodons. 3rd. In the convex outline of each ridge in the transverse direction when unworn, the central mammillæ being the most elevated; and in the absence of the longitudinal line of division along the middle of the crown which is so characteristic of the Mastodons on the one hand, and so generally absent in the Elephants on the other. 4th. In the enormous quantity of laminated cement that fills up the valleys in most of the species. 5th. In the pronounced arc of a circle described by the molars as we trace them forwards in the jaws, as in the Elephants, instead of

the nearly horizontal line of protrusion observable in the most typical Mastodons, such as the species of North America and of Simorre. 6th. In the obverse relation of the planes of detrition of the opposed teeth during wear, the *inner* side of the upper teeth, and the *outer* side of the lower, continuing higher in the Stegodons, as in the typical Elephants, while the converse holds in the Mastodons. 7th. In the absence or extreme rarity of premolars in both jaws, and of mandibular tusks, neither of which, though occurring among certain Mastodons, have been as yet detected among the Stegodons. The aggregate weight of so many points of agreement turns the balance strongly on the side of the Elephants.

It is deserving of remark, that all the species of the Stegodon group at present known belong to the series indicated in the preceding part of this paper, as being of the Dinotherian or Eurycoronine[1] type, in that the crowns of the molars are broad, the ridges uniformly transverse, and the valleys open, without being in the least degree interrupted by outlying tubercles, as is seen in the Hippopotamine or 'Stenocoronine' type. Sir Proby Cautley and myself have thought we could distinguish four species of Stegodon, namely *E.* (*Steg.*) *Cliftii*, *E.* (*Steg.*) *bombifrons*, *E.* (*Steg.*) *insignis*, and *E.* (*Steg.*) *Ganesa*? The first, besides other distinctive marks, is at once characterized by the broad distinction of the antepenultimate and penultimate true molars being six-ridged, or *hexalophodont* in number, the last true molar conformably presenting an additional ridge and 'talon.' The first of the 'intermediate series,' namely the last milk molar, has not yet been observed entire *in situ* in the jaw, but I am prepared to expect that, when determined, it will present five or six ridges. This species, the remains of which were discovered by Mr. Crawfurd in Ava, constitutes the passage into the Mastodons; this is indicated both by the limited (*i.e.* senary) number of ridges, and by the circumstance that the crowns of the molars exhibit a very obsolete or indistinct trace of a longitudinal bipartient cleft, as in the Mastodons. Further, in the only well-preserved palate-specimen at present known, the outer side of the upper molars is higher, and the inner side lower and more worn, being another point of agreement with the Mastodontoid rather than with the Elephantoid type. Where nearly allied groups inosculate, the intermediate

[1] It has been suggested to me that the contrasted terms of Dinotherian and Hippopotamine types may mislead, through being supposed to imply a greater amount both of affinity and of difference than is intended. I propose therefore to substitute for the former 'Eurycoronine' or broad-crowned type, and for the latter 'Stenocoronine' or narrow-crowned type.

forms commonly partake more or less of the character of both. But the sum of the characters, and more especially the identical form of the divisions of the crowns and the ridge-formula, connect this species more with the other Stegodons than with any group of *Mastodon*. The next two species, namely, *E.* (*Steg.*) *bombifrons* and *E.* (*Steg.*) *insignis*, have from seven to eight, and occasionally even nine ridges in their different intermediate molars; and their teeth are exceedingly alike in character, although the species are distinguished by an excessive amount of difference in the form of the cranium, greater even than that between the African Elephant and the Mastodon of North America. Regarding the specific distinctness of *E.* (*Steg.*) *Ganesa* I am by no means so well assured; this species is chiefly founded on a huge cranium in the British Museum with long tusks, presented by Colonel Baker. I have not been able to reconcile the form of this cranium with either that of *E.* (*Steg.*) *insignis* or *E.* (*Steg.*) *bombifrons*; but at the same time I must confess that I have failed in tracing its dentition satisfactorily as a distinct form through different ages. Three species of this group appear to be distinct beyond question; and I cite them chiefly, on the present occasion, in reference to determinations in the sequel, to show that Elephantine forms may approach very closely in their dental characters, as occurs in other Mammalia, and still be distinct species.

The Stegodons, so far as is at present known, are exclusively confined to Tropical Asia. It is therefore unnecessary, on the present occasion, to describe in detail the peculiarities of their dental characters; and I shall confine myself to the leading points in their 'ridge-formula,' that place them in connexion with the Mastodons on the one hand, and with the Loxodons on the other.

2. *Elephas* (*Stegodon*) *Cliftii*.—Of this species the youngest milk teeth are as yet unknown. The third upper milk molar, or first of the intermediate molars, is seen *in situ* in the specimen represented in the 'Fauna Antiqua Sivalensis,' Pl. XXX. fig. 1 *b*, entire on one side, but worn down to the common base of ivory, so that the divisions of the crown have entirely disappeared, leaving no certain data for determining the ridge-formula of this tooth. Behind it, in the same palate specimen from Ava (presented by Colonel Burney to the British Museum), the three anterior ridges of the antepenultimate true molar are seen *in situ*, the posterior half being broken off. But the detached tooth on the upper jaw is seen entire, and beautifully preserved, in the specimen fig. 2 of the same plate, presenting six ridges and a small hind talon. The same tooth is represented by fig. 6 of Pl. XXXIX. of Mr.

Clift's Memoir (Geol. Trans., vol. ii. 2nd series). It is there described as an upper molar tooth of *Mastodon Elephantoïdes*, under which title Mr. Clift included specimens that are referred in our arrangement to two distinct forms.[1] The Elephantine affinities of this tooth are indicated by the absence of a longitudinal line of division along the crown, and by the great number of points (about eleven in each) that enter into the composition of the ridges. The penultimate true molar (or third of the intermediate series) is presented *in situ* on both sides of the superb palate specimen represented by Clift in Pl. XXXVI. of the memoir above referred to. It is proved to be the penultimate by its large dimensions, and by the circumstance that part of another tooth of still larger size, and inferred to be the last, is seen behind it in the jaw. The same specimen is more carefully represented by figs. 3 and 3 *a* of Pl. XXX. of the 'Fauna Antiqua Sivalensis.' The crown-ridges are all more or less worn, and partly damaged by fracture; but enough remains to show that the tooth was composed of six ridges and a hind talon. The last true molar of the lower jaw is represented by fig. 5 of Pl. XXX. of the 'Fauna Antiqua Sivalensis.' The crown consists of eight ridges and a talon. The anterior large fang had been absorbed, but the portion of the crown sustained by it remains. The six posterior ridges have their fang elements confluent into a continuous plate or shell, thus maintaining the Elephantine affinity indicated by the crown characters. (See Pl. V. figs. 1 & 2.) Taking the data furnished by these teeth, the cipher 6 is seen to prevail in the two last of the intermediate molars, indicating a Hexalophodont type, or $6 + 6 + 8$ for the ridge-formula of the true molars.

3. *Elephas* (*Stegodon*) *insignis*.—The only other form among the Stegodons which it is necessary to notice is that for which the name of *E.* (*Steg.*) *insignis* has been proposed. (See Pl. V. figs. 3 & 4; and vol. i. Pl. IV. fig. 1.) In this species the crown-ridges are constructed very closely upon the model of *E.* (*Stegodon*) *Cliftii*, the principal difference consisting in the much greater mass of laminated cement that fills up the

[1] Mr. Clift, in his excellent memoir, includes the Ava fossil Proboscideans under two species, *Mastodon latidens* and *Mastodon Elephantoïdes*. In the 'Fauna Antiqua Sivalensis,' and in the synoptical table appended to the preceding part of this paper, the former name is retained for the specimens of the *Tetralophodon* type, figured by Mr. Clift, Pl. xxxvii. figs. 1 & 4; Pl. xxxviii. fig. 1, and Pl. xxxix. figs. 1, 2, & 3. Of the others, the palate specimen, Pl. xxxvi. (*Mastodon latidens*, Clift), together with the detached molar, Pl. xxxviii. fig. 6 (*Mastodon Elephantoïdes*, Clift), are referred to *E.* (*Stegodon*) *Cliftii*; and the lower jaw specimen, Pl. xxxviii. fig. 2 (also *M. Elephantoïdes*, Clift), is referred to *E.* (*Stegodon*) *insignis*. The specimens regarded by him as of his *M. Elephantoïdes* being here considered to belong more properly to the genus *Elephas*, it became necessary to resort to another specific designation. Hence the origin of *E.* (*Stegodon*) *insignis*.

valleys. In some sections as many as eleven distinct strata of this substance may be counted.[1] But the ciphers yielded by the 'ridge-formula' place the species in close affinity with the Loxodons, and more particularly with the species named *E. (Lox.) planifrons*. Remains of *E. (Steg.) insignis* have been discovered in immense abundance in the Sewalik hills, and specimens illustrative of the dentition of every age and in every stage of wear are contained in the great Indian collection of the British Museum. The rigid constancy in the number of ridges observable in the two subgenera of *Mastodon* is no longer maintained. As stated in the preceding part of this paper, the higher the numerical expression of the 'ridge-formula' in the species, the more liable is the number of ridges to vary within certain limits dependent on the race, sex, and size of the individual; and the molars of the lower jaw often exhibit an excess. After examining a very large number of specimens of all ages, the prevailing numerical expression of the ridge-formula, exclusive of 'talons,' in *E. (Stegodon) insignis* has appeared to me to be thus:—

Milk molars.	True molars.
$2+5+7:$	$7+\ 8\ +(10-11)$.
$2+5+7:$	$7+(8-9)+(11-13)$.

I have already remarked that all the known species of *Stegodon* belong to that species of the Proboscideans in which the ridges are transverse, and the valleys open. It may be expected, without much temerity, that other species remain to be discovered in the fossil state, in which the mammillæ will be disposed more or less alternately, with outlying tubercles and interrupted valleys, as in the 'Stenocoronine' type.

IV.—Pentalophodon.

From the circumstance that so many Mastodons present the ciphers either 3 or 4 constantly in the ridges of the intermediate molars of two groups of species, and that in the next allied group, *Stegodon*, *Elephas (Stegodon) Cliftii* in like manner presents the cipher 6 in two of the same teeth, while the prevailing number augments in *E. (Stegodon) bombifrons* and *E. Stegodon insignis*, with faith in the harmony of nature it might have been with some confidence anticipated that another Proboscidean type remained to be discovered in the fossil state, intermediate between *Tetralophodon* and *Stegodon*, in which a quinary ridge-formula would be presented, constituting a third subdivision of the genus *Mastodon*, to which the name of *Pentalophodon* would be applicable.

It appears to me that the Indian fossil species *M. (Tetralo-*

[1] Fauna Antiqua Sivalensis, Pl. vi. fig 7.

Fig. 1

Fig. 2.

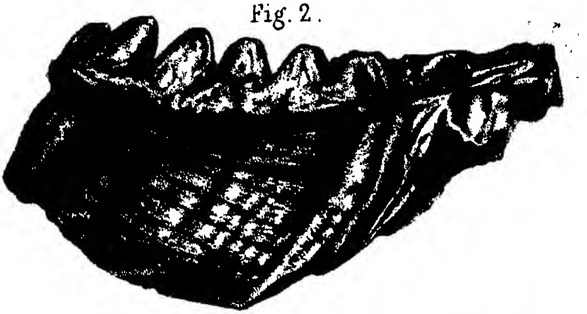


Fig. 3.

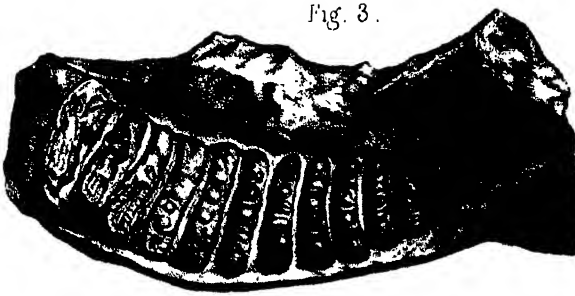
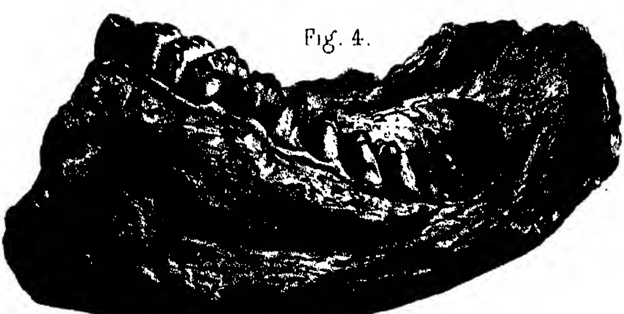


Fig. 4.



G.H.Ford del. L.Aldous lith. Harrison & Sons Impt.

1, 2 Elephas (Stegodon) Cliftii. 3. 4. Elephas (Stegodon) insignis.

phodon) *Sivalensis*, figured in the 'Fauna Antiqua',[1] presents the first indication in that direction. In the 'intermediate molars' of this form, both upper and lower, besides the usual anterior 'talon' and four large ridges, there is a fifth ridge, somewhat reduced in size, but exactly corresponding with the other in form, composed of several large mammillary tubercles, separated from the next ridge by a valley, and throwing off an outlying tubercle, which reduces the valley, as in *M.* (*Tetralophodon*) *Arvernensis*, to lateral gorges. This fifth ridge is not a mere offset from, or subordinate appendage to, the fourth ridge after the ordinary manner of a 'talon.' It is supported directly by the last fang, and is separated, both on the outer and inner sides, from the latter by the intervening valley. In most of the species of *Mastodon* having alternate mammillæ, the hind 'talon' in the upper molars (and conversely in the lower) forms a crenulated 'bourrelet,' which is given off from the inner posterior mammilla, descending obliquely around the base of the outer division, and generally more or less effaced by the pressure of the next posterior molar during its progress forwards. In a fine specimen of a penultimate upper molar of *Mastodon Sivalensis*, which is now before me, the fifth ridge, although well developed and attaining the height of the fourth, bears no trace of a 'talon' appended to it; while an antepenultimate lower, which I have also before me, shows distinctly five ridges, the last differing in no respect of complexity or development from the others, except in being a little smaller, and it bears a distinct crenulated adpressed 'talon' appendage, having the appearance of a terminal 'bourrelet.'

In the preceding part, when discussing the conditions of the 'ridge-formula' in *Trilophodon* and *Tetralophodon*, it was stated that while the penultimate milk molar always presents one ridge less than the 'intermediate molars,' the last true molar presents one ridge more. Conformably, the last true molar in *M. Sivalensis* presents six ridges, besides the hind 'talon,' thus maintaining throughout, so far as the dentition is known, the numerical characters to be inferred from the ridge-formula, as ascertained in *Trilophodon* and *Tetralophodon*.[2] I consider it sufficient, on the present occasion, to call attention to this as a point of some interest and importance in the systematic and palæontological relations of the Proboscidean family, in reference to the indications they present of an order of successive serial development, without entering in detail upon the evidence in support of the view here taken. That the species is a distinct form is abundantly borne out

[1] *Op. cit.* Pl. xxxvi. figs. 1–6. (See vol. i. p. 467.—Ed.)
[2] See vol. i. Pl. vii. fig. i. – Ed.

by the marked characters of the skull,[1] independently of the strong dental distinctions. The ridge-formula for the true molars in *Mastodon Sivalensis* is inferred to be

$$\frac{5+5+6}{5+5+(6-7)};$$

and when the dentition is fully made out, it is anticipated that the complete ridge-formula will be nearly thus :—

Milk molars.	True molars.
$\frac{2+4+5}{2+4+5}$.	$\frac{5+5+6}{5+5+(6-7)}$.

V.—Characters of the Loxodons.

1. *General Remarks.*—The existing type of this group is the African Elephant, which Fred. Cuvier, in 1835, proposed to erect into a distinct genus under the name of *Loxodonta*, having reference to the rhomb-shaped discs of wear of the molar teeth. He held the opinion that, in its general form, in the structure of its grinders, in the form of the head, and in that of some of the external parts of the organs of sense, the African differs as much from the Indian Elephant as the Dog from the Hyæna, the Paca from the Agouti, the Lagomys from the Hare, and the Hog from the Phacochœre.[2] Besides the African Elephant, the group *Loxodon* comprises three fossil species, of which one is Indian, *E.* (*Loxod.*) *planifrons*, from the Sewalik hills, and two European, namely, *E.* (*Loxod.*) *priscus* and *E.* (*Loxod.*) *meridionalis*.[3] The essential characters by which the molar teeth of the Loxodons differ from those of the Stegodons is that the ridges or colliculi, while closely corresponding in regard of number, are considerably more elevated and compressed. This is best seen when they are sawn up longitudinally and vertically. The section in the Stegodons exhibits a series of chevron-shaped ridges, of which the height does not much exceed the base, with thick enamel and assimilating closely in form to the true Mastodons;[4] while in the Loxodons[5] it presents a succession of elongated wedge-shaped processes, with thinner enamel, constituting an intermediate stage between the former and the nearly parallel thin-plated ridges of the next group, *Euelephas*. In the technical definition of the subgenera appended to the preceding part this distinction is attempted to be expressed by the terms 'coronis complicata' applied to the teeth of the

[1] *Vide* 'Fauna Antiqua Sivalensis,' Pl. xxxii. (See Pl. x. and p. 464 of vol. i.—Ed.)

[2] F. Cuvier, 'Histoire Naturelle des Mammif.' tom. iii., 'Éléphant d'Afrique.'

[3] A third European *Loxodon* was subsequently discovered by Dr. Falconer, viz. *E.* (*Loxodon*) *Melitensis* (Falc.)—Ed.

[4] 'Fauna Antiqua Sivalensis,' Illustrations, Pl. ii. figs. 6 *a* & 6 *b*.

[5] *Ibid.* Pl. ii. figs. 4 *a* & 4 *b*.

Stegodons, and 'coronis lamellosa' to those of *Loxodon* and *Euelephas*.[1] It forms the basis of the arrangement of the species of the Proboscidea, by De Blainville, into two groups, *i.e.* 'Éléphants mastodontes' and 'Éléphants lamellidontes,' the whole comprised in a single genus, *Elephas*.

2. *African Elephant.*—De Blainville has attempted to describe and figure in detail the dental succession, from the first milk molar of the young calf to the last true molar of the adult state, in *E.* (*Loxod.*) *Africanus*. Of some of the 'intermediate molars,' he was not in possession of perfect specimens; in these cases, his determination of the ridge-formula can only be regarded as approximative. Another point, which materially affects the numerical estimate of the ridges assigned by him to the different teeth is, that in every case he counts the accessory ridgelets, or 'talons,' as ridges. His results may be expressed thus for the number of ridges in the different teeth:—

Milk molars.	True molars.
$\frac{4+7+6}{4+7+?}$.	$\frac{7+(9-10)+10}{?+(8-9)+(10-12)}$.

This determination is open to the objections that the third milk molar has a smaller number of plates assigned to it than the penultimate, which is very much smaller in size, and that the penultimate upper true molar is described by De Blainville as possessing the same number of ridges as the last. This occurs in no species of Mastodon or Elephant. De Blainville has figured an instructive specimen, which proves that the theoretical first or pre-antepenultimate milk molar is occasionally developed in the lower jaw of the African Elephant.

Professor Owen has briefly described the ridge-characters of the teeth of this species in the 'Odontography,' and assigns the following numbers to the ridges in the six successive molars, *i.e.* 4 + 7 + 7 : 7 + (8—9) + (10—12), the last of the ciphers being attributed to the sixth (or last true) molar of the lower jaw. In this estimate, the 'talon' is apparently reckoned in some of the cases as one of the principal ridges. I have examined the specimens upon which De Blainville's descriptions were founded, and various molars of all ages in different collections contained in museums in this country or

[1] These terms are adopted from the logical and accurate Illiger. The expressions 'Bildung' or 'Entwickelung,' 'Pyramidal,' 'Prismatisch,' applied by Von Meyer and Bronn to characterize the difference in structure between the teeth of Mastodon and Elephant appear to convey the same meaning respectively as the 'dens complicatus' and 'dens lamellosus' of Illiger (*vide* Illiger's 'Prodrom.' p. 22, and Bronn's Lethæa Geognost. Band ii. pp. 753 and 797).

abroad, and, excluding the two 'talons,' the ridge-formula in the African Elephant has appeared to me to be thus:—

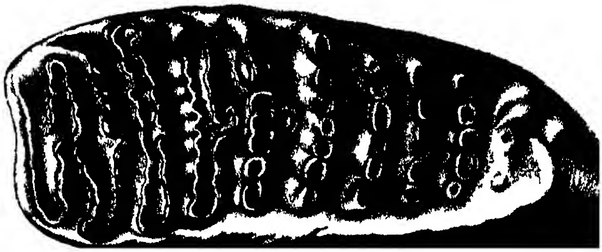
Milk molars.	True molars.
$\frac{3+6+7}{3+6+7}$	$\frac{7+\ \ 8\ \ +10}{7+(8-9)+11.}$

The amount of development in the posterior talon is subject to considerable variation. In some cases it forms merely an insignificant splent appended to the last ridge; in others it attains the proportions of a reduced ridge, and, according to the degree of its evolution, it may be differently regarded by different naturalists, either as a distinct ridge or as an appendage. The hypisomerous character of the ridge-formula, in the intermediate molars of theLoxodons, is exhibited by the succession of ciphers assigned above to the ridges in the last milk molar and the antepenultimate and penultimate true molars, *i.e.* $7+7+8$. I have seen specimens in which the penultimate true molar of both the upper and lower jaws presented nine ridges. Cuvier states that he had never observed a tooth of the African Elephant showing more than ten plates. A last molar of the upper jaw, left side, procured from Cape Coast by Mr. Samuel Turner, exhibits, in a length of 11 inches, thirteen plates, *i.e.* eleven principal ridges, besides front and back talons.

The well-known and very constant distinctive characters in the molars of the African Elephant consist of the rhomb-shaped pattern yielded by the disc of the ridges after advanced wear, together with the relative narrowness of the crowns as compared with those of the Indian Elephant. (See Pl. VI. fig. 1, and vol. i. Pl. IV. fig. 3.) The systematic signification of these peculiarities appears to me to be, that this species among the Loxodons represents the group of forms in *Trilophodon* and *Tetralophodon*, described in the preceding part as having the ridges of their molars characterized by outlying flanking tubercles and blocked-up valleys, and as belonging to the 'Stenocoronine' type. In the African Elephant, the digital processes are less divided and more speedily confluent than in the Mastodons; each ridge throws out, in front and behind, a mesial angular projection, which meets or overlaps the corresponding part of the next contiguous ridge; and the transverse continuity of the valleys, which are filled up with cement, is interrupted in consequence. The adjoining rhombs, in the process of wear, are in contact by their opposed angles, and at length become confluent in a common disc. The angular expansions of the discs are the modified homologues of the flanking tubercles of the Mastodons; and as the character prevails in several forms among the latter, its presence in so pro-

Fig. 1.

Fig



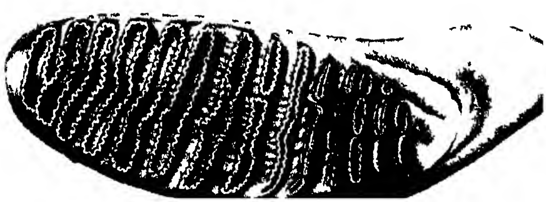
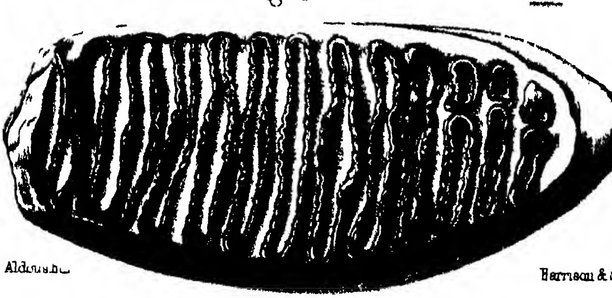


Fig 4



J Ford del J Alder sc. — Harrison & Sons Impt

1 Elephas (Loxodon) Africanus 2 E (Loxodon) planifrons
3 E (Euelephas) Indicus 4 E (Euelephas) primigenius

nounced a degree in the African Elephant might have led us *a priori* to expect in nature other allied species in which it would be more or less exhibited. Premolars have not as yet been observed among the teeth of this species.

3. *E.* (*Loxodon*) *planifrons*.—In order to show the constancy of the hypisomerous character of the ridge-formula among the Loxodons, as furnishing a reliable aid in the distinction of certain of the European fossil Elephants, it is necessary to refer briefly to the dentition of another form in the subgenus, being the Indian extinct species from the Sewalik hills, *E.* (*Lox.*) *planifrons*, the characters of which, yielded both by the skull and teeth, are so pronounced, and the accessible materials in European collections so abundant, as to place its specific distinctness wholly beyond question. In this form the ridge-formula of the deciduous and true molars is thus:—

Milk molars.	True molars.
$\frac{3+6+7}{3+6+7}$	$\frac{7+\ 8\ +10}{7+(8-9)+(10-11)}$.

Vertical sections of an upper and lower true molar contrasted with corresponding teeth of the African Elephant are shown by figs. 5 *a* and 5 *b* of Pl. II. of the 'Fauna Antiqua Sivalensis.' (See also vol. i. Pl. IV. fig. 2.) The ridges are seen to be much more elongated vertically than those of *E.* (*Steg.*) *insignis* (vol. i. Pl. IV. fig. 1), but to be considerably less so than in the African Elephant (vol. i. Pl. IV. fig. 3). Other distinctive characters from the latter species consist in the enormous quantity of cement which fills up the valleys and envelopes the ridges, and in the much greater thickness of the folded plates of enamel. When the teeth are regarded from the crown aspect, the discs of wear assimilate more in general form to those of the existing Indian than of the African Elephant. They form transverse bands, which are broader, fewer in number, and wider apart than in the Indian Elephant, sometimes with the bounding edges of enamel nearly parallel, in other cases showing a slight angular expansion, or throwing out a salient loop (outlying tubercle) near the middle, as in figs. 8 and 9 of Pl. XIV. (F.A.S.), but never exhibiting the systematic lozenge-shaped expansion so characteristic of the African Elephant. (See Pl. VI. fig. 1.) The enamel edge or *machœris* is very thick, and generally free from plaiting. The tips of the digital processes are thick, and yield well-marked circular discs before they become confluent by wear. These characters are represented throughout by the figures of Plates XI. and XII. of the 'Fauna Antiqua Sivalensis,' which include the principal varieties in the form of the molar-crowns. (See also Pl. VI. fig. 2.)

Of the different teeth in the upper jaw the antepenultimate upper milk molar is represented by fig. 1 of Pl. XII. of the 'Fauna Antiqua,' and in vertical section by fig. 1 *b*, showing three principal ridges, with a basal ridgelet in front, and a hind talon. The penultimate milk molar, of which a finely preserved unfigured specimen is now before me, presents six principal ridges, with a distinct front and back talon. It measures 2 inches in length by 1 inch in front, and 1 inch behind. The third milk molar and the antepenultimate or first true molar are present *in situ* on both sides in another palate specimen. The former exhibits the discs of six worn ridges, besides a seventh ridge behind, which is enveloped by cement. The first true molar is in a germ state, and presents seven intact principal ridges, together with a front and back talon. The penultimate true molar is seen *in situ* in the upper jaw specimens, figs. 4 and 6 of Pl. XII., presenting eight main ridges. The last true molar is seen in germ, intact on one side and well worn on the other, in the cranium-specimen, figs. 1 to 4 of Pl. X., with eleven ridges and talons. In other cases, such as fig. 6 of Pl. XII., the last upper molar presents only ten ridges.

Of the inferior molars, the antepenultimate and penultimate milk teeth are seen *in situ* in the lower jaw fragment, fig. 10 of Pl. XIV. F.A.S., drawn to the natural size.[1] The former presents three ridges with talons, and the latter six principal ridges besides talons. Another lower antepenultimate is yielded by the young mandibule, figs. 7 and 7 *a*, of Pl. XII., also presenting six principal ridges. The empty alveolus of the small antepenultimate tooth is exhibited in the same figure at *b*. The last milk molar, or first of the intermediate series, is seen in fig. 8 of the same plate to possess seven principal ridges, with a front talon. The antepenultimate or first true molar is represented by fig. 10, showing also seven principal ridges. The two specimens last mentioned are further remarkable in showing each a premolar tooth *in situ*. The penultimate true molar varies in presenting eight or nine ridges. The specimen, fig. 8 of Pl. XI. of the same work, exhibits a penultimate, with nine ridges and a small back talon. The last true molar is beautifully preserved on either side in the mandibular specimen, fig. 2 of Pl. XI., showing about eleven principal ridges.[2] Other specimens of the same tooth, presenting nearly the same number of ridges, are seen in the specimens figs. 12 and 13 of Pl. XII.[3] The

[1] At the bottom of the plate in the 'Fauna Antiqua,' the specimen is referred to *E. Hysudricus*, but this is an error.—See vol. i. page 442.—[Ed.]

[2] Reproduced in Pl. VI. fig. 2.—[Ed.]

[3] Fig. 13 *a* of the same plate has no connection with fig. 13. It is misplaced there, and belongs to the series of illustrations of *E.* (*Euelephas*) *Hysudricus*, not to *E.* (*Loxod.*) *planifrons*.

last true molars, upper and lower, are subject to a certain amount of variation in the number of the ridges, which will be more fully considered in the remarks upon the next subgenus *Euelephas*. All the molars, both upper and lower, are relatively to the length of the crown much broader in this extinct species than in the existing African Elephant.

A very important part of the dentition of *E.* (*Loxodon*) *planifrons*, in relation to the systematic affinities and characters of the Elephants, remains to be considered, namely the premolars. The presence of these teeth in this species is adverted to in the preceding Part (p. 6), and in the observations which follow the technical definition of the genus *Elephas* (p. 13). The lower jaw fragment, fig. 8 of Pl. XII. F.A.S., cited above, displays three teeth *in situ*, viz. in the posterior extremity the last milk molar, in front of it the penultimate milk molar (*b*) nearly worn out, and emerging from below the latter a small vertically succeeding premolar (*c*) is exhibited. The penultimate premolar is represented of natural size (*c*) in fig. 9 of the same plate. It is considerably smaller in all its dimensions than the antepenultimate milk molar, fig. 1 *a*, drawn to the same scale. It is of a roundish form, and shows no distinct indications of ridge-divisions. It was therefore, in all probability, of but small importance functionally in the economy of the species. In like manner, figs. 10 and 10 *a* of the same plate furnish an illustration of the last lower premolar *in situ*, in front of the first or antepenultimate true molar. That the latter is one of the true molars is clearly proved by its large dimensions and by the mature form of the jaw. Fig. 11 *b* represents the last premolar (natural size) vertically divided through the middle, the anterior portion being wanting. Although partly emerged, it is still embedded in the alveolus, and intact, while the tooth behind it is well worn. It is of comparatively small size, but presents distinct indications of two transverse ridges, terminating in the thick digitations characteristic of the species.

Of the upper premolars only the penultimate has been discovered *in situ*. A beautiful example is seen in the cranial fragment represented by figs. 4, 5, and 6 of Pl. VI. of the same work, on the left side of the palate, the tooth of the right side having dropped out. Behind the premolar are the last milk molar, well worn, and the antepenultimate true molar in germ. The premolar, in plain view, is of a very broad and round oval form. The crown is composed of a number of tubercles irregularly huddled together, somewhat in a botryoidal manner, and presenting no distinct indication of transverse ridges. The surface of the crown has attained

the level of the first disc of wear of the tooth immediately behind; it bears but slight marks of abrasion, which, however, appear to indicate that it was opposed to a corresponding tooth below. This penultimate premolar is represented of the natural size by fig. 6 of Pl. VI. of the work above referred to.

Dr. Kaup has given a very instructive illustration[1] of the beautifully preserved young lower jaw of *M.* (*Trilophodon*) *angustidens*, which I detected (*antea*, pp. 38, 73) in the collection of M. Ziegler-Ernst at Winterthur. The two premolars are seen *in situ* in this specimen, the penultimate emerged, the last embedded in the jaw, below the last milk molar. The specimens cited above place it beyond question that the Sewalik species, *E.* (*Loxodon*) *planifrons*, had the premolar series as complete numerically as either *Dinotherium giganteum* or *M.* (*Trilophodon*) *angustidens*. I have already explained that palæontologists have heretofore entertained an opinion adverse to this being found to occur in any species of Elephant.

The above remarks may appear to be beside the professed object of the essay, but they are essential to the proper estimate of the characters to be adduced in the sequel, in proof of the specific distinctness of the British fossil Loxodons, which will now be considered.

4. *Elephas* (*Loxod.*) *priscus*.—Has the African Elephant ever been found in the fossil state in Europe? and if so, within what geographical limits? These are questions of the highest interest, and to which a new kind of importance attaches, from the investigations of some of the later French palæontologists. In 1821 Professor Goldfuss, of Bonn, published an account, with figures, of a reputed fossil molar, found in the collection of the Canon Mehring, of Cologne, the precise origin of which was not well ascertained. The crown presents seven discs of wear, with the well-marked rhombs, shaped exactly as in the existing African Elephant. The dimensions of the tooth are—length, 5·4 inches, by an extreme width of 2·3 inches, determining it to be a true molar. The specimen is described as being much decomposed; the crust of cement friable and of an ochre-yellow colour, the ivory greyish white, and the plates of ivory and enamel separated by fissures. In another memoir of a later date, the same author describes other teeth, presenting similar characters, and asserted to be derived from a diluvial deposit, on the banks of the Ruhr in Westphalia; and he affirms that he had seen in other collections similar fossil teeth. He

[1] Beitrage, Heft iii 1857, p 9, tab. i figs. 1–3.

inferred that the valley of the Rhine was formerly inhabited by a species of Elephant which more nearly resembled the existing African species than *E. primigenius* does the existing Indian. But he did not hazard an opinion whether or no it was specifically different from the existing African, which could only be satisfactorily established by the discovery of a skull, and he named the species provisionally. Cuvier questioned the fossil authenticity of these specimens, and of other instances of the same nature, which he enumerates. In the autumn of 1847 I had an opportunity of examining the specimens above referred to, in company with Dr. Goldfuss, at Bonn. They were much sun-cracked, resembling in this respect grinders of the existing Asiatic Elephant as they are presented in India after long exposure to atmospheric agencies; but the fracture and texture of the ivory yielded the glistening sericeous appearance characteristic of recent teeth, and conveyed to my mind a corresponding impression that the molar was probably of modern origin.

The celebrated C. E. von Baer describes, with exemplary caution, two reputed fossil molars from the north of Germany, resembling exactly those of the African Elephant. One of these he unhesitatingly regards as being of modern origin, from the circumstance that some of the cellular membrane lining the alveolus was still preserved upon the tooth.[1] The other, discovered in the sandy foundations of the monastery of St. Adalbert, near Dantzic, is, from the description, manifestly of the African Elephant; and the tooth, from its partially worn condition, is evidently not one that had been naturally shed. Von Baer cites the opinion of Rathke, that it may have been derived from a casualty in some travelling menagerie, but he with reason doubts if an African Elephant was ever brought to Dantzic, either during the Roman empire or subsequently. After carefully balancing the texture and consistence of the specimen and the circumstances under which it appears to have been found, he could arrive at no satisfactory opinion whether it was really fossil or not, and he leaves the point undetermined.[2] It may be remarked on this head, that the freshness of preservation of teeth and tusks of Elephants discovered in Post-Pliocene deposits furnishes no argument against their being of really fossil

[1] 'Quid amplius, tunicæ et telæ cellulosæ alveolum vestientis partem in dente siccatam invenimus. Partes molles per tot sæcula in nostris regionibus servari posse credat Judæus Apella! Nos vero dentem non fossilem suspicamur.' He also describes a tooth certainly fossil, but of uncertain origin, in the Museum of St. Petersburg, referring it to *E. priscus* (Mém. de l'Acad. de St. Pétersbourg, tom. i., Bulletins Scientif. p. 16).

[2] 'Sic status fossilis testimonia certa non cognoscimus et non habemus quo catalogi assertum confutemus.'

antiquity; for ivory tusks of the Mammoth have been found in silt in Britain, in such perfect preservation as to have been fit for turning into chess-men.[1] I have examined a skull of the Mammoth, discovered in the Lehm of the valley of the Rhine, and now preserved in the Museum at Mannheim, which is quite as fresh, and appears to retain as much animal matter as crania of existing Elephants that have long been exposed in public collections. It is in a better state of preservation than skulls of domestic animals that have been buried for a long time within the historical period and subsequently disinterred.

The most characteristic specimen of *Eleph.* (*Loxodon*) *priscus* that has yet been discovered in British deposits is a tooth which was purchased by the late Mr. König, then keeper of the Mineralogical and Palæontological Gallery, for the British Museum, of Mr. Ball, a well-known trading collector. It was stated to have been procured from the brick-earth excavations at Gray's Thurrock, in the valley of the Thames—a locality rich in Mammalian fossils, and first brought to notice by the able investigations of Mr. Morris. No precise particulars as to the history of the specimens were ascertained or put on record by Mr. König. But on paying a visit to Gray's Thurrock, in company with the late Professor Edward Forbes and Colonel James, in the summer of 1845, with the express object of examining the association of extinct Mammalia in this very interesting deposit, I was informed on the spot that the tooth in question belonged to the skeleton of an Elephant, the greater part of which was found spread out in one place by the workmen, when digging for brick-earth. Most of the bones were destroyed in the operation; but besides this molar, another, belonging to the same animal, was retained by Mr. Meeson, the proprietor of the brick-field.

The specimen (No. 39,370 of the Brit. Mus. MS. Cat.) is a last molar, left side, of the lower jaw. The mineral characters, friability, test by the tongue, colour, dull fracture, and general appearance, leave no doubt as to its being a veritable fossil. Mr. König, to place this important point beyond question, permitted it to be sawn up, and the condition of the interior was equally conclusive of its fossil nature. The longitudinal section is represented by fig. 7 *b* of Pl. XIV. of the 'Fauna Antiqua Sivalensis;[2] (reproduced in Pl. VII.

[1] The fossil tusks of the Mammoth form an article of commerce in Siberia, and are largely used in the manufacture of ornaments and statuettes. &c.

[2] The dimensions of the tooth are given in the description of it in the 'Fauna Antiqua Sivalensis.' See vol. i. p. 441.—[ED.]

figs. 1 and 2); and if it be compared with fig. 4 *b* of Pl. II. of the same work,[1] representing a vertical section of a penultimate lower molar of the existing African Elephant, it will be seen that there is the closest general resemblance between the two, in all that relates to the relative proportions of the alternate layers of ivory, enamel, and cement, and in the cuneiform character of the ridges. If the comparison be extended to the sections of the teeth of the Mammoth and of the existing Indian Elephant, figs. 1 and 2 *a*, Pl. I., of the same series, the difference from them is equally apparent. The specimen consists of the part of the tooth extending from the sinus between the first and second fangs to the last ridge. The anterior portion supported by the first fang, and which in the African Elephant consists of the front talon and the two foremost ridges, is wanting. The fragment exhibits the discs of eight worn ridges finely preserved. The three anterior discs are worn low; the next four are successively less and less abraded; the last ridge shows only the tips of two digitations, with a considerable interval between them. There is no distinct hind talon. The discs of wear present an unmistakable resemblance to those of the existing African Elephant, in breadth, lozenge-shaped outline, and mesial expansion; but when examined in detail, there are obvious points of distinction. In the living species the lozenges are more strictly rhomb-shaped; the salient edge of enamel is distinctly crimped; the lateral terminations of the rhombs are flattened; and the mesial angles of the contiguous discs are either more approximated or overlap each other laterally. In *E.* (*Loxodon*) *priscus*, the discs are rounded at their lateral terminations, and broader. Although the mesial expansion is quite as great as in the African Elephant, it is less sudden, and in the general outline there is a tendency to a reniform or obsolete crescentic shape, the anterior enamel boundary of each disc being somewhat concave, and the posterior convex. The horns of the crescents are bent abruptly forwards. This is best seen in the fourth, fifth, and sixth discs; the first three, being more worn, show this peculiarity less distinctively. Another obvious character is that the enamel-plates are thicker, and present a less degree of crimping than in the African Elephant.

When viewed laterally, the resemblance to the existing species is as marked as in the crown aspect. The ridges are alike broad in both, and the fangs are similarly disposed, those which support the five posterior ridges being confluent into a common shell. (Compare figs. 7 *a* and 5 *a* of Pl. XIV.,

[1] A section of the penultimate upper molar is shown in Pl. iv. fig. 3 of vol. i. —[Ed.]

'Fauna Antiqua Sivalensis.') The vertical height of the seventh ridge, although but slightly worn, does not exceed 2½ inches, while the greatest width of the crown is 3 inches. The flexuous bend of the enamel-plates vertically, at the posterior end as seen in the section, is not a distinctive peculiarity, since it is met with in inferior molars both of the Indian Elephant and of *E.* (*Eueleph.*) *antiquus*.

The principal dimensions of this specimen are—

Extreme length of crown-surface, 8· in. Width of crown-surface at first ridge, 2·35 in. Width of crown-surface at the fourth ridge, 2·8 in. Width of crown-surface at the seventh ridge, 1·8 in. Height of the seventh ridge, 2·5 in. Width of second disc at mesial expansion, 0·95 in.

There are eight discs of wear to a length of 8 inches, being an average of one ridge to the inch, a proportion corresponding closely with that presented by the oldest teeth of the African Elephant. The front fang, in the last lower molar of the latter species, generally supports two principal ridges besides the anterior talon. It is inferred, therefore, that the corresponding fossil tooth of *E.* (*Loxodon*) *priscus*, when entire, was composed of ten or eleven ridges, and that it was about 11 inches long.

Another specimen (No. 18,966 of the British Museum Collection), also reputed to have been procured from the brick-earth deposits of the valley of the Thames, is represented by fig. 6 of Pl. XIV. of the work above cited. It is a fragment mutilated at both ends, showing only the entire discs of five partially worn ridges. The outline of the discs corresponds very closely in form with those of the posterior ridges of the larger specimen from Grays Thurrock, described above. There is the same mesial angular expansion, and a still greater tendency to the discs assuming a crescentic form. The mutilated condition of this specimen renders its identification somewhat doubtful; but it is inferred to belong to *E.* (*Loxod.*) *priscus*, and to be a penultimate molar of the lower jaw, left side. The dimensions are—

Length, 5· in. Width of the crown behind, 3· in. Height of the crown behind, 2·8 in.

Besides the five entire ridges, the fractures pass through the middle of a disc at either end; so that the specimen may be considered to possess six ridges in a length of 5 inches, being an average width of ·83 to each, near the summit, where but little worn.

The only other British specimen referable to this species, that has come under my observation, is a fragment of a lower jaw, with which I have lately become acquainted, in the rich and valuable collection of Mammalian remains from the Norfolk coast, between Cromer and Lowestoft, formed by the

Rev. John Gunn, of Irstead, who has liberally placed this specimen, with many others, at my disposal for description.[1] It is a rolled and mutilated fragment, comprising the symphysis and anterior part of both rami, the beak-apophysis being entirely rubbed off. A single molar is present on the left side; none on the right, which is very mutilated.

The tooth, which is inferred to be the penultimate true molar, presents the crown nearly entire and well worn. Its length is determined by the anterior and posterior fangs, which are exposed. The front talon, together with a portion of the first principal ridge, supported upon the anterior fang, are partially broken. The crown exhibits the discs of the seven posterior ridges and part of the first, indicating in all eight main ridges. There is no posterior talon, the last ridge descending continuously, for insertion upon the fang. The crown is very narrow in front, and expands gradually as far as the sixth ridge. The discs of wear are broad, with a mesial angular expansion as in the African Elephant; but at the same time they exhibit a very pronounced crescentic outline, the horns or lateral terminations being much more bent forwards than in the specimen from Grays Thurrock. The general contour of the anterior enamel-plate of each disc is markedly concave, and the posterior one convex. The mesial expansion of the third disc, measured between the outer surfaces of the enamel, is exactly $\frac{3}{4}$ths of an inch. The discs are uniform in shape, from the first to the last, the difference between them depending solely upon the greater or less amount of wear. The projecting edge of enamel is irregularly crimped, and to a much more obvious degree than in the Grays Thurrock specimen. In this respect it approaches more nearly the character of *E.* (*Euelephas*) *antiquus*, to be described in the sequel. (Pl. VII. figs. 3 & 4.)

The principal dimensions of this fragment are—

Vertical height of the ramus, measured from the lower margin to the summit of the first ridge of molar, 9·1 in. Length of the molar crown (part wanting in front), 6·7 in. Width of crown at the second disc, 1·9 in. Width of crown at the fourth disc, 2·4 in. Width of crown at the sixth disc, 2·6 in. Height of the seventh ridge, about 3·0 in. Mesial expansion of the second disc of wear, 0·75 in. Mesial expansion of the seventh disc of wear, 0·7 in.

In front of the molar there is a well-marked triangular cicatrix, indicating the remains of a nearly filled up fang-cavity, at the anterior angle of which a small portion of an ivory stump is visible. The plane of the cicatrix slopes suddenly downwards upon the diasteme, and the line of the interior margin does not follow the direction of the alveolar

[1] Mr. Gunn kindly forwarded this specimen to me to be figured by Mr. Dinkel. See Plate vii. figs. 3 & 4.—[Ed.]

margin of the molar *in situ*. The length, measured from the anterior angle of the fang-scar to the back of the tooth, is 8·1 inches. A question arises, whether this alveolar scar belongs to a distinct younger tooth that had been shed; or does it represent the remains of an anterior portion of the h now seen *in situ*, which was supported by a fang anterior to that described above as being the large front fang? In the latter case, at least three other ridges would have to be added to the crown, making eleven in all, and the tooth would then present the character of the last lower of the African Elephant instead of the penultimate. There is no positive character to decide the question either way; but I am led to consider that the tooth has its full proportions in what now remains, from the circumstance that the crown narrows so much at the first ridge, *i.e.* to less than two inches, while it is three inches wide behind. The fang-scar in this view is regarded as indicating the position of a shed antepenultimate.

The jaw is so rolled and mutilated, that it affords but few distinctive characters for description. The most striking point is the very great proportional height of the ramus, which in a line with the anterior termination of the molar is upwards of 9 inches. This proves that the jaw is that of an adult animal, and that the molar is certainly not of a younger age than a penultimate. The inner side of the ramus is flat, and the jaw appears to have been very high and compressed in front. What remains of the symphysis indicates that the gutter was broad, and that the rami diverged considerably. Two mentary foramina are present on the left side, with an interval of about 3 inches between them, and close to the edge of the diasteme.[1]

This valuable specimen was found on the Palling beach, near Happisburgh, where fossil molars of elephants are so abundant. There is no certain information from what bed it was derived, whether from the 'Elephant bed' of Mr. Gunn, below the 'submerged forest-bed,' or from the 'laminated blue clay' above it. But he is satisfied that it was derived from a deposit below the 'dark-mud Boulder-clay.' The same uncertainty applies to the greater part of the Mammalian remains found along the beach from Happisburgh to Mundesley. They have rarely or ever been observed in the cliffs *in situ*; and in the present instance there is no matrix upon the specimen to aid in arriving at an opinion

[1] In this respect the jaw in question would seem to differ from *E. Africanus*, in which species the mentary foramina are always placed a considerable distance from the edge.—Note by G. Busk, F.R.S. in Quart. Journ. Geol. Soc.

G.H.Ford del. J.Dinkel lith. W.West imp.

Elephas (Loxodon) priscus

upon this point. The specimen is entirely free from ferruginous impregnation. The ivory is white, and adheres freely to the tongue.

Authentic remains, referable to this obscure form, are so rare in European collections, that it is of importance to make known any specimen calculated to throw light upon it. By the liberal and obliging permission of Dr. Emilio Cornalia, I was enabled to examine minutely a very fine fossil molar, preserved in the Natural History Museum of Milan, which I refer to *E.* (*Loxodon*) *priscus*. This specimen is a last molar of the lower jaw, left side, nearly entire, the only deficiency being in the anterior talon and part of the first ridge borne by the large anterior fang. The crown exhibits twelve principal ridges and a posterior talon, the ten anterior of which are worn down into transverse discs, while the last three are but slightly abraded. All the discs of wear present a broad rhomboidal expansion in the middle, as in the African Elephant, but modified by a crescentic tendency as above described in the fossil molars from Grays Thurrock. The first disc is fractured vertically, and confluent at either side with the second, which is also nearly confluent, from advanced wear, with the third. The fourth disc is very broad (antero-posterior diameter), and exactly corresponds in form with the first disc of the Grays Thurrock specimen, the mesial expansion being ·75 of an inch. The outer termination of this disc is bent forwards somewhat like the fourth in that specimen, but more abruptly pronounced. The ivory surface is deeply excavated, so that the enamel edge projects in high relief above it. The fifth and sixth discs are of a similar form; but, being less worn, they are less expanded. Their *cornua* are bent forwards on the inner side, with the crescentic character seen in the fourth, fifth, and sixth discs of the Gray's Thurrock specimen. The anterior enamel-plate of the sixth disc projects very much (to the extent of seven-tenths of an inch) above the contiguous stratum of cement, while the included ivory surface is but slightly depressed. The seventh, eighth, and ninth discs present a corresponding form, getting narrower successively in consequence of being less worn, but each showing more or less of a mesial angular expansion. The tenth ridge is but slightly worn, and the disc is barely continuous across. The eleventh and twelfth ridges show each two distinct discs. The posterior talon shows the tips of two denticles or digitations, like the last ridge of the Grays Thurrock specimen. To the posterior surface of the last there is appended a single thick digitation, which projects backwards in a salient gibbosity, being the converse of what is seen in the re-entering sinus, on the posterior surface of that specimen.

The grinding-surface is very concave from back to front, a chord stretched from the front to the last ridge being fully 1·4 inch above the level of the sixth and seventh discs. It is also a good deal contorted, the anterior inner side sloping backwards and outwards, while the posterior outer angle slopes forwards and inwards, corresponding precisely in this respect with the specimen of the last lower molar of *E.* (*Euelephas*) *Hysudricus*, represented by fig. 13 *a*, Pl. XII. of the 'Fauna Antiqua Sivalensis.'

The enamel plates are very thick; and their outer edges present an appearance of crimping, caused by the deep vertical grooving of the outer surface, namely, that in contact with the stratum of cement; but they are not plaited.

The principal dimensions are as follows:—

Length of crown, about 12· in. Width of crown at fourth ridge, 3·1 in. Width of crown at sixth ridge, 3·35 in. Width of crown at eighth ridge, 3·4 in. Width of crown at tenth ridge, 3·1 in. Width of crown at twelfth ridge, 2·6 in. Width of posterior talon, 1·65 in. Height of crown at fourth ridge (much worn), 1·6 in. Height of crown at sixth ridge, outer side, 3·1 in. Height of crown at ninth ridge, outer side, 4·5 in. Height of crown at twelfth ridge, outer side, 5·2 in. Mesial expansion of fourth disc, 0·75 in.

The crown includes twelve ridges in a length of about 12 inches, being an average of one inch to each. The specimen was compared with an exact drawing, of the natural size, of the Grays Thurrock molar; and the two agreed in the closest manner, making allowance for their different stages of wear. This very important specimen bears a record of having been discovered by Count Gazzola, in a calcareous deposit upon Monte Serbaro, in the valley of Pantena, about eight miles from Verona, along with the remains of other herbivorous quadrupeds. In its mineral condition and appearance it presents undoubted evidence of being a true fossil.

This completes what I have to adduce in proof of *E.* (*Loxodon*) *priscus* being a distinct species;[1] and it must be freely admitted that, considering the area explored and the number of museums examined, both in Britain and abroad, the evidence, although strong in kind, is, in the form of authentic materials, quantitatively very limited. It may be asked, if this be a well-founded species, how does it happen that determinable remains of it are everywhere so rare? To which it is replied that the Pliocene *Mastodon* (*Triloph.*) *Borsoni*, respecting which there is now no question among those Mammalian palæontologists who have studied the remains attributable to it, is in the same predicament, and

[1] Subsequently, in 1859, Dr. F. found in the University of Rome, and described in his note-book, a magnificent last lower molar of *E. priscus* from Monte Verde, having all the characters of the Milan specimen. The crown was 12 in. long and had twelve plates.—[Ed.]

almost equally rare. A single molar of that species was discovered by Abbé Borson in 1820, in the Pliocene deposits of the Astesan, since which date, up to 1856, not a single additional specimen had been acquired for the collections of Florence, Pisa, Turin, Milan, or Pavia, although the ossiferous Pliocene strata of the Astesan had subsequently been largely laid open by railway-cuttings. The detailed proofs have been obtained from deposits in Auvergne and elsewhere in France. In 1845, I was unable to reconcile the characters yielded by the Grays Thurrock specimen with those of any recognized species of fossil elephant, except *E. priscus*; and after an interval of twelve years, with a large addition of experience in the investigation of the subject, and with more materials, my conviction of its being distinct is as strong as that in favour of any other species in the genus. In Mammalian palæontology, when the evidence furnished by the teeth can be crucially tested, by means of the varied characters of the cranium and of the bones of the extremities, a safe and satisfactory conclusion as to the distinctness or otherwise of the species can generally be attained. But when a few teeth only are available, the area of the evidence becomes very limited, and there is a constant unperceived tendency in the observer either to magnify the value of the differential remarks, or to underrate them, as the case may be, according to his inclination, from some extraneous influence, to make the species distinct or merely a variety of some other form. In this case I have tried to guard myself against a bias either way, and the evidence has appeared to me to be conclusive of the distinctness of the species. Although so little is known of the details of the different teeth, the ridge-formula is inferred to be 7 : 7 + 8 + 11 in the last milk molars and three true molars, as in the African Elephant. The known limits to the dimensions of the molars in the Elephants, coupled with the average great antero-posterior extent of the ridges, in this form, namely, one inch to each, necessarily involves a limited number of the latter. The distinction from the African species is founded upon the characters that the lozenges are regularly rhomboidal in the one, and somewhat crescentic, with the angular expansions more apart, in the other. Both species belong to the 'Stenocoronine' type of *Loxodon*. The distinction from the fossil form to be next described, *E.* (*Loxodon*) *meridionalis*, is borne out by well-marked characters, the crowns of the molars in the latter being constantly very broad, the digitations thick and distinct, and the discs of wear free from mesial rhomboidal expansion. If *E.* (*Loxod.*) *priscus* could be reconciled with any other fossil species, it would be with *E.* (*Euelephas*) *antiquus*, in

which the discs of the worn ridges exhibit a certain amount of expansion. But in this species the ridges are very numerous, elevated, and attenuated, their number, as in the existing Indian Elephant, ranging as high in the last lower molar as from twenty-four to twenty-seven, while in *E. priscus* they do not exceed twelve or thirteen. These points will be brought out more in detail in the sequel, when treating of these species.[1]

Elephas (*Loxodon*) *priscus* occurs in Italy in the Sub-Apennine Pliocene strata of the Romagnano; in England, in the fluviatile deposits of the valley of the Thames, and in undetermined strata on the coast of Norfolk, but believed to be below the 'Boulder-clay.' I have not observed it among the exposed specimens in the public collections in Paris, nor in any museum in France that I have visited. The name is enumerated by Pomel in his 'Catalogue of the Fossil Remains of the Loire and the Allière,' as having been found in the Plain of Salièvе, Collection of Laizer. He describes it briefly as *Elephas priscus* (Goldf.): 'Espèce ayant les lames de ses molaires disposées comme dans l'Éléphant d'Afrique.' Whether this means the ancient race of the existing species attributed to the valley of the Rhine, or the distinct fossil form, with crescentic discs of wear, I am unable to determine.

5. *E.* (*Loxodon*) *meridionalis*, Nesti.—Of this species, the materials in European collections, more especially in Italy and England, are fortunately so abundant and perfect as to place its specific distinctness beyond question. But this conclusion has been so long opposed by the highest palæontological authority, namely, by Cuvier, De Blainville, and Owen, and the geological inferences involved in it are of such importance that I consider no apology necessary for entering fully upon the evidence bearing on the subject.

The 'Val d'Arno Superiore' has, from remote ages, been celebrated for the vast abundance of fossil remains found there. Huge bones and teeth of Elephants were especially numerous. A large collection of these was formed by Targioni Toretti, which ultimately found its way into the Grand Ducal Museum at Florence; and numerous additions were made by Nesti, who, in 1808, soon after the publication of Cuvier's 'Memoir of the Mammoth' (Annales du Muséum, tom. viii.), examined the Tuscan Elephantine remains, and was so satisfied of their difference from those of the Mammoth, that he proposed for them two specific designations, namely, *Elephas meridionalis* and *E. minutus*. Influenced by the fact

[1] In his memoir on *E. Columbi*, written five or six years subsequently to that on Mastodon and Elephant, Dr. F. expressed the opinion that *Loxodon priscus* was a form of *E. antiquus*.—[ED.]

that Cuvier had laid so much stress upon the peculiar form of the lower jaw, and guttered beak of the symphysis, as distinctive marks of *E. primigenius*, Nesti (not a professed anatomist) was naturally led to direct his attention, in the first instance, chiefly to the same parts in the Val d'Arno remains. Unluckily the specimen that presented the most pronounced beak had lost its molar teeth; Nesti assumed it to be of an Elephant. But this selected 'pièce justificative' for his *Elephas meridionalis* was proved by Cuvier to be the lower jaw of *Mastodon Arvernensis*,[1] and *E. minutus* to be merely a young Elephant.

After a long interval, during which Cuvier had visited the Tuscan collections, Nesti brought out another memoir upon the subject, in which, upon greatly extended observations on specimens of all ages, from the fœtus upwards, including crania, lower jaws, molars, tusks, and bones of the extremities, he upheld the soundness of his first inference in regard to the distinctness of *E. meridionalis*, while he admits tacitly the force of Cuvier's criticism upon his second species, *E. minutus*. The memoir is accompanied by figures of the cranium, lower jaws, and molars, but so imperfectly executed, that they proved of little service either in establishing his case or in guiding other palæontologists to a satisfactory conclusion. Another circumstance, which materially damaged the authority of Nesti upon a question of such difficulty and importance, is that he states that, after examining a vast number of molars of all ages, he had found them to vary so much—some having thick plates, others thin, and the same tooth presenting such different patterns, according to its age and degree of wear—that he had abandoned the characters yielded by the molar teeth as worthless (!) for any reliable marks of specific distinction. In the teeth themselves he had discovered no sensible differences from the characters figured and described of those of *E. primigenius*. This singular conclusion is, in some measure, explained by the fact that hardly a specimen of a molar of the true Mammoth exists in the Florentine Museum for comparison. It is, perhaps, still more remarkable that the experienced eye of Cuvier should have glanced over the multifarious evidence supplied by the Tuscan collections, without being convinced that *E. meridionalis* was a well-founded species, considering the rapidity with which he seized, and the logical precision with

[1] *Note from Dr. F.'s Note-Book.*—'Florence, May 20, 1859. Again examined this lower jaw. It is of an animal not quite adult, and probably contained the antepenultimate and penultimate teeth. It is clearly a *Mastodon*. Another lower jaw near it has the spout even a little longer, but not like *M. longirostris* or *M. angustidens*.'—[ED.]

which he characterized, the distinctive marks of the Mammoth from the existing Indian Elephant.

Failing the teeth, Nesti drew his specific distinctions from the form of the cranium and lower jaw. Ample evidence is afforded by them for establishing *E. meridionalis* as an independent form.

It would be both tedious and beside the scope of this essay to detail the various opinions that have been expressed by different palæontologists respecting *E. meridionalis.* They will be found embodied in systematic works upon the science; and, on the present occasion, I shall confine myself to such as have had most influence, either in throwing light upon the characters of the species or in discrediting it.

Cuvier rested the specific distinction of the molars of the Mammoth upon three characters, namely, the great width of the crown, the attenuation of the plates, and the absence or small amount of crimping in the edges of the enamel. He admits that he had observed some notable exceptions as regards the two last. The first example that he cites is the 'dent de Porentrui,' from the valley of the Rhine, above Strasburg, which is remarkable for a great amount of plaiting in the enamel-plates. This specimen, however, is not fossil, but belongs to the existing Elephant.[1] The only other exceptions cited are three Italian specimens from Romagnano, Monte Verde, and the Val d'Arno, in all of which the plates are very thick, and which in reality belong to *E. meridionalis.* No exceptional illustration is adduced from Siberia, or any other northern locality, where the true Mammoth prevails. It is implied that they constantly present attenuated and uncrimped plates. Cuvier therefore supposed the two last characters to be inconstant, and adhered to the great width of the crown, which, however, is common to the Mammoth and to *E. meridionalis.* It is obvious that the prepossession in his mind in favour of a single European fossil species of Elephant, which is manifest throughout the 'Ossemens Fossiles,' had unconsciously led the great anatomist to undervalue the very characters which he was the first to inculcate.

The Abbé Croizet, to whom palæontology is indebted for so much valuable research on the fossil fauna of Velay, was the first who had the courage to question the decision of Cuvier against *E. meridionalis.* In his work upon Puy-de-Dôme, he has figured and described a fragment of an upper (?) molar (lower left of Croizet and Jobert) discovered at Malbattu. It is a good deal mutilated, and the figure is not

[1] 'It is a lower left, and beyond all question not fossil, but of the existing Indian Elephant. This was first pointed out to me by M. Lartet.'—*Note by Dr. F.*—[ED.]

so exact as to be conclusive; but in the form of the discs of wear, in the thickness of the enamel-plates, and in the slight degree of crimping along the edges, it differs alike from *E.* (*Euelephas*) *primigenius* and *E.* (*Euelephas*) *antiquus*, and corresponds with Italian specimens of *E. meridionalis*. In Plate X. fig. 1 of the same work, he gives a representation of a fossil molar discovered by Lecoq at Clermont, which exhibits similar characters. He refers to Nesti's researches, and sums up by inferring that, as there are two living Elephants, so there were two fossil species—the one with attenuated plates, being the Mammoth of Siberia, the other with thick plates, as seen in specimens from Porentrui, Romagnano, Monte Verde, Laufen (in Germany), and the Val d'Arno. He considered the facts sufficient, but assigned no other name to the second species than that of 'Éléphant de Malbattu,' and awaited the results of further discovery for confirmation of the inference.

Professor Owen has entered very fully into the question of distinct species, in the part devoted to *Elephas* of his Report to the British Association for 1843, and subsequently reproduced in his separate work on the 'British Fossil Mammalia.' The result at which he arrived, after examining a vast number of specimens, was that there had been only one species of fossil Elephant in Britain, namely, *E. primigenius*; and while fully recognizing the marked differences presented by molars from different localities and different deposits, he had found so many intermediate gradations, that he was unable to draw a well-defined line between the thick-plated and thin-plated varieties. The consideration of the grounds upon which this opinion was founded will fall more properly into the discussion on the fossil species of *Euelephas*. In regard to *E. meridionalis*, he alleges that the variety of molar (*i.e.* thick-plated) on which this proposed species is founded occurs not only in England, but in Siberia and as far north as Eschscholtz Bay;[1] and, in proof, he appeals to the specimens described by Buckland in the appendix to the 'Voyage of the Blossom.' Professor Owen refers to this thick-plated variety of the Mammoth certain British molars, which will be noticed in the sequel, as belonging to *E.* (*Loxod.*) *meridionalis*. I may remark that the conclusions to which I have been led on all the points involved in the question of distinct species or varieties in the European fossil Elephants are widely dif-

I got yesterday from Mr. Christy the molar of the Elephant from the Ural mountains. It is certainly neither of *E. primigenius* nor of *E. antiquus*, and so far as the evidence goes it is of *E. meridionalis*, although the plates are a little more approximated than usual. If really from the Ural mountains, it is of great importance.—*Letter to M. Lartet, Dec.* 31, 1863.—[ED.]

ferent from those set forth in the 'Report to the British Association' and in the 'British Fossil Mammalia.'

Early in 1844, my attention was directed to the European fossil Elephants as subjects of comparison with the Indian fossil species from the Sewalik hills. I had satisfied myself, upon the indisputable evidence of entire crania and well-pronounced dental distinctions, that, exclusive of the Stegodons, there were three Indian fossil species of *Elephas*, two from the Miocene Sewalik deposits, namely, *E.* (*Euelephas*) *Hysudricus* and *E.* (*Loxodon*) *planifrons*, and one from the Pliocene beds of the Nerbudda, *E.* (*Euelephas*) *Namadicus*, which were as distinct as the two existing species are from each other. On comparing them with British specimens, I found that there was one series among the latter which resembled the molars of *E.* (*Loxod.*) *planifrons*, and that they were chiefly derived from the 'Norwich Crag' or its vicinity; while another series, found in vast abundance on the 'Oyster-bed' and in other localities along the Norfolk coast and elsewhere in England, differed constantly from characteristic specimens of the Mammoth of the superficial glacial deposits, and were closely allied to *E.* (*Euelephas*) *Namadicus* from the Nerbudda. I was in this manner convinced that there were two British fossil species, besides *E. primigenius* and *E.* (*Loxodon*) *priscus*. The prevailing opinion, at that time, among the best geological authorities in England, was that the Crag deposits were either of a Miocene or very old Pliocene age. On referring to the description and figures given by Nesti, Croizet, and Jobert, and by Cuvier, of molars attributed to *E. meridionalis*, I found that they were so indecisive, either from their reduced scale or their imperfect execution, that it was impossible to identify the British specimens satisfactorily by them; and in the metropolitan collections I could discover no good series of Val d'Arno specimens to assist me. In consequence, I came to the conclusion, but hastily as it proved, that the fossil species from the Norfolk coast and fluviatile beds of the Thames Valley was the same as the extinct Elephant of the Val d'Arno; and the figures illustrative of it in the 'Fauna Antiqua Sivalensis' were published under the name of *E. meridionalis*, while those from the 'Crag' and superjacent 'Elephant-beds' were designated *E. antiquus*, under the impression that it was the oldest of European Elephants then known. But, on paying a visit afterwards to the Oxford Museum, I found Val d'Arno specimens in Dr. Buckland's collection which satisfied me that I had made a mistake, and that the 'Crag' molars were identical with those of *E. meridionalis*. It was too late to correct the error in the published plates; and it appeared to me that less confusion would arise

from my continuing, in the subsequent plates, the nomenclature which I had adopted in the earlier ones, than if altered names were partially introduced, as I intended to give a full correction of the whole in the letter-press. I regret to find that the delay in the publication of this correction has led to a good deal of misconception and to misgiving as to the validity of the species both at home and abroad. I beg leave to explain now, that all the plates bearing the name of *E. meridionalis* in the 'Fauna Antiqua Sivalensis,' including the outline-figures of crania in Plate XLII., belong to *E. antiquus*, while those that bear the latter name belong to *E. (Loxodon) meridionalis.*[1] In the descriptions which follow they will be cited as such.

Before entering upon the details of the British specimens of *E. meridionalis*, I think it best to communicate the results of my examination of the Tuscan collections, as the evidence furnished by all parts of the skeleton is more complete and abundant in them than anywhere else.

A. *Tuscan Specimens.*—The Grand Ducal Museum at Florence contains seven crania, or considerable portions of crania, of this species. One of these, a late acquisition, is attached to a mounted skeleton, the trunk part of which is complete, but the extremities wanting. Another specimen consists of a crushed cranium, with the lower jaw attached, containing the three milk molars, more or less consolidated both above and below, *in situ*. The first milk molar is free from wear, proving that the animal must have died, if not in the fœtal state, at least very soon after its birth. Another specimen, also of a young calf, shows both maxillaries, with the palate and floor of the nasal cavity entire, the rest of the cranium being wanting. The two anterior milk molars in this specimen, and in the corresponding lower jaw, are worn to a degree indicative of the animal having been about a year old. There are five adult crania, indicating by the form of the tusks both sexes. Three of those described by Nesti, of enormous size, are still extant. In another, of a very old animal, the tusks are beautifully perfect. Another specimen, limited to the incisive sheaths, also shows the tusks in their natural position quite perfect. There are numerous lower jaws and bones of the extremities of colossal dimensions, and an abundance of detached molars of all ages and in every stage of wear. These Elephantine molars (including probably both *E. meridionalis* and *E.* (*Euelephas*) *antiquus*) were so common in the Val d'Arno, near Figlinie, that the

[1] This correction must be taken with the important qualification already pointed out in vol. i. p. 443, note 1.—[ED.]

peasants were formerly in the habit of using them promiscuously with boulders in constructing the stone-walls surrounding their fields. The osteological materials available for the determination of the Val d'Arno Elephant, which exist in the Florentine Museum, are therefore as abundant, and nearly as complete, as those of the Mammoth at Moscow.

a. *Upper Milk Molars.*—The beautiful specimen comprising both maxillaries shows the two front or antepenultimate and penultimate milk molars in place on both sides, the alveolar part of the third being wanting. The antepenultimate, on the right side, is perfectly entire in its contour, but well worn. The general form is a broad oval, narrowest in front and broadest in the middle. It presents three principal ridges, with a front and back talon. The discs of wear are very wide (antero-posteriorly), with thick enamel-plates, exactly like fig. 4 of Plate IX. of Cuvier's 'Ossemens Fossiles.' The dimensions of this tooth are ·95 inch in length by ·75 inch in width at the second ridge where broadest.

The penultimate upper milk molar of the same specimen is fully formed and consolidated. It presents a broad oblong crown, narrow in front, but wide behind, composed of six principal ridges, with a front and back talon. The anterior talon and three first ridges are touched by wear, the other three being intact. The ridges are wide apart, and the discs of wear show thick enamel-plates. The enamel-surface, where denuded of cement, is very rugose from deep and intricate grooving, as is seen in specimens from the Crag. The tooth bears no mark of pressure behind from an impelling last milk molar. The dimensions are: length of crown, 2·5 in. by 1·1 in. of width at first ridge, and 1·6 in. at the fifth ridge where broadest. The height of the crown at the fifth ridge is also 1·6 in., the tooth thus presenting at a very early age one of the distinctive marks of the species, namely, a proportionally broad crown, with a low elevation to the ridges.

The original of fig. 4. of Plate IX. of the 'Ossemens Fossiles' is also a penultimate upper milk molar, of which a part is worn away. What remains presents five ridges and a hind talon well worn. The ridges are wide apart, with thick enamel plates.

The last (third) upper milk molar is seen in a detached specimen in the Florentine Museum (marked No. 98), the cement of which is covered with dendritic crystallizations of manganese. It is well worn, but quite entire, showing the anterior talon and the disc of pressure against the preceding tooth. The crown presents eight ridges, besides a front and back talon. All of them are more or less touched by wear, but none confluent, except the first with its adjoining talon.

The three anterior ones present continuous transverse discs, with thick unplaited enamel, the outer surface of which, where in contact with the cement, shows a crimped edge caused by the section intercepting the superficial grooves. The third disc exhibits a small mesial loop in front. The fourth and fifth ridges show each three distinct transversely oblong discs, with about three digitations to each. The sixth and seventh show five distinct oval or roundish discs. The apex of the eighth ridge is barely touched, the posterior talon being enveloped by cement. The general contour of the crown is a broad oblong. The ridges are separated by wide open intervals, and the enamel-plates are thick. The dimensions of the specimen are :—

Extreme length of crown, 4·6 in. Width of ditto at first ridge, 2·0 in. Width at seventh ridge, 2·5 in. Height of seventh ridge, barely worn only, 2·0 in.

From these dimensions, it will be seen that the length of the crown is less than twice the width, and that the width exceeds the height of the seventh ridge; or, in other words, a broad crown with low ridges, wide discs, and thick enamel.

b. *Upper True Molars.*—The antepenultimate (or fourth of the entire series in the order of antero-posterior succession) is presented *in situ* in a mutilated cranium of a semi-adult and probably female Elephant, which comprises both maxillaries with two molars in each, and the incisive bone of the left side with the corresponding tusk. The anterior of the molars is the antepenultimate, the crown of which is so far advanced in wear that the anterior ridges are ground down into a common flat disc. There are six distinct discs of as many ridges behind, with a talon. The enamel is very thick, with deep grooving on the exterior surface, but scarcely any plaiting. The digital tips of the little-worn back ridges are thick, well separated, and they yield well-defined rings by abrasion. It is inferred that the crown possessed eight ridges besides the talons.

A detached left antepenultimate, entire as regards the crown, but without fangs, shows nine ridges with a front and back talon; the first two ridges are worn, the next intact. It agrees with the specimens above described in the leading characters of well-separated ridges, with thick unplaited enamel, and a low elevation to the plates, the dimensions being :—

Length of crown, 6·2 in. Width of ditto in front, 2·4 in. Height of the third ridge, 3·8 in. Height of the eighth, 3·1 in.

Another detached antepenultimate shows only eight ridges besides a front and back talon. It has the three first ridges barely touched by wear, showing annular discs. The enamel is very thick and rugous, the digitations are deeply divided

and distinct, and the ridges wide apart. The length of the crown of this specimen is $6\frac{1}{2}$ inches. The other dimensions were not taken. The number of plates in the antepenultimate upper molar appears to vary from eight to nine.

Of the penultimate upper (fifth in the order of succession) molar there are numerous noble specimens in the Florentine Gallery. One of the left side, having the enamel tinged black, and grey cement, shows nine principal ridges and a front and back talon. The first four ridges only are worn; the digitations are thick, well-separated, and distinct, the ridges wide apart, the crown broad, and the height low. The dimensions of this specimen are:—

Length of crown, about 9·0 in. Width of ditto at first ridge, 3·2 in. Width of ditto at base of fifth, 4·0 in. Extreme height of fifth ridge, 5·4 in.

In this specimen we have an illustration of the constancy of the distinctive characters—namely, a broad crown and the height of the enamel-ridges, not much exceeding the width, being nearly in the ratio of 11 : 8.

Another detached penultimate upper molar, having the first five ridges worn, shows ten ridges and a talon. The digitations in this case are so distinct that the discs of each of the first three ridges present three subordinate discs. The dimensions of this specimen are:—

Length of crown, 8·75 in. Width of crown at first ridge, 3·5 in. Height of crown at sixth ridge, unworn, 5·2 in.

This tooth exhibits all the distinctive characters noted of the other teeth. The number of plates in the penultimate upper molar of *E. meridionalis* appears to range from nine to ten.

Of the third or last upper true molar (sixth in the order of succession) there are numerous specimens in the Florentine Museum, some of them *in situ* in entire crania, others detached. They are distinctly shown in good preservation in three huge male skulls, with enormous tusks, and in one female (?) head with smaller tusks; but in each of these cases the most anterior ridges are, from extreme age, worn out; and I prefer drawing an illustration from a perfect detached specimen for the exact determination of the ridge-formula. Among the most instructive of these are a pair belonging to opposite sides, and so much alike that they were probably of the same individual. The molar of the right side (No. 9,261 of the old Cat. Florent. Mus.) shows thirteen ridges, besides talons. The discs of the first two ridges and talon are nearly confluent into one common wide surface; but the presence of the large anterior fang proves that no part of the crown is lost in front. The eight succeeding ridges are more or less abraded, the three last

being intact. In consequence of the plane of advanced wear intercepting the ridges obliquely, the enamel-plates appear to slope a great deal where they emerge from the cement, and the edges project much above it. The ninth ridge, which is but slightly abraded, exhibits eight or nine distinct thick digitations. The crown contracts a good deal towards the hind talon, which is enveloped by a thick mass of cement. The principal dimensions are—

Extreme length of crown, about 11·0 in. Width of crown at the fourth ridge, 4·3 in. Width of ditto at base of ninth ridge, 4·0 in. Height of enamel-plate at tenth ridge, 4·5 in.

In this specimen, all the characters noticed as distinctive of the anterior true molars are strongly marked. There are thirteen main ridges in a length of 11 inches, being an average of about 0·85 inch to each; and, taking the talons into account as distinct ridges, there would still be an average of about 0·75 inch to each ridge. The relatively low elevation of the ridges and the very great width of the crown are also remarkable.

The last molars present in the crania above referred to differ in no respect from the one just described, more than is necessarily dependent on their more advanced state of detrition. The lower down they are ground the wider is the expansion of each disc, and the more approximated are the enamel-plates of the contiguous ridges. In all of them the enamel-plates are thick, deeply channelled on the outer surface, but hardly ever plaited, the inner edge being even or disposed in easy flexures.

A very fine illustration of the characters of the palate and two last true molars on either side is presented by the Monte Pulgnasco specimen discovered by Cortesi, and figured by him in the 'Saggi Geologici,' tab. 1, fig. 1. It was found at no great distance from the classic cranium of Monte Zago, upon which Cuvier founded his *Rhinoceros leptorhinus*, as an extinct species devoid of any bony partition between the nostrils. Both specimens are now preserved in the Natural History Museum of Milan, and, by the permission of Dr. Emilio Cornalia, I had an opportunity of examining them minutely. The precise identification of both is of considerable importance in the general argument of the Mammalian Fauna of the Pliocene period in Europe. The skull of the Rhinoceros is exactly as Cuvier in the first instance, and Dr. Cornalia subsequently described it, *i.e.* without a trace of an external nasal septum. The mutilated cranium of the Elephant is a superb fragment, comprising the maxillaries and palate, with the penultimate and last true molars of *E. meridionalis*. The penultimate is nearly worn out, the discs

of the last four ridges being confluent in the middle, but separated laterally by a 'Dedalian' channel-machæris, showing the thick unplaited laminæ characteristic of the species. The last molar presents from twelve to thirteen principal ridges, with front and back talons. Five of these ridges are worn, the rest are intact and enveloped by cement. The crown is very broad; the thick digitations have their apices worn off into circular discs, exactly as in the Val d'Arno specimens, and the ridges are low relatively to the width of the crown. The opposite lines of teeth converge in front. The figure of this specimen, given by Cortesi, is very imperfect in execution, and inexact. Fig. 2 of the same plate, a supposed representation of the lower jaw, is made up of two fragments of opposite sides joined by their anterior ends, and therefore highly deceptive. The tusks of this cranium are of enormous dimensions, and yield an oval section with diameters of 9½ by 7½ inches. Other bones of the same skeleton are preserved in the Milan Collection, one of them being a sacrum of immense size.

c. *Lower Milk Molars.*—The antepenultimate and penultimate milk molars, beautifully preserved, are present in a fine specimen of a young lower jaw of the same age as the fragment comprising the corresponding upper teeth. The two fragments are considered by the authorities of the Museum to be upper and lower of the same individual, and they agree exactly in their mineral condition and appearance. On the right side the antepenultimate is wanting; on the left it exhibits a well-worn crown, composed of three principal ridges with front and back talons. It is much smaller and more compressed in front than the upper tooth, and in the general form it is somewhat cusp-shaped, like the corresponding tooth of the Sewalik *E.* (*Loxod.*) *planifrons.*

The penultimate (or second) inferior milk molar presents six principal ridges, besides a front and back talon; the three anterior ones more or less worn, the next intact. Making allowance for the difference of upper and lower, the tooth is exactly like the corresponding penultimate above. The plates are thick, and the ridges wide apart, the vallicular intervals being but imperfectly covered with cement. On the right side there are about six loose unconsolidated plates of the third milk molar in the alveolar cavity; on the left side only the empty alveolus. The principal dimensions of the specimen are:—

United length of the two milk molars, 3·0 in. Length of the first, 0·7 in. Length of the second, 2·4 in. Width of ditto at first ridge, 0·8 in. Interval between the anterior edges of the two milk molars, 1·7 in.

The last milk molar is beautifully preserved in an older

jaw, although still young, comprising the right ramus, with the remains of the second milk molar in front, and the empty alveolus of the antepenultimate true molar behind. The age of the interposed third milk molar is therefore very pointedly indicated. The crown presents eight principal ridges, with front and back talons. The four anterior ridges alone are affected by wear—the first showing two distinct, curved and reniform discs, with the convexity in front; the second, three continuous but separate discs; the third, four; the fourth barely abraded, but exhibiting the rings of five digitations. The tooth, in its longitudinal direction, has the usual curve, being concave on the outer side. The ridges are wide apart, and enwrapped by an enormous layer of cement, very much as in the young teeth of *E.* (*Loxod.*) *planifrons*. In its general form, the crown differs notably from the second milk molar, in presenting a nearly uniform width from front to rear. There is no indication of plication in the enamel of the plates, nor any outlying mesial loops. The specimen is hard and heavy, resembling in its mineral condition the hard Sewalik fossils when a little weathered. The dimensions of the tooth are :—

Length of crown, 4·6 in. Width of ditto at first ridge, 1·6 in. Width of ditto at fifth ridge, 1·8 in.

Another very fine detached specimen of the last milk molar, lower left, with the first four ridges worn, shows also eight principal ridges, besides talons. Posteriorly it is denuded of cement; the ridges are wide apart, and the enamel very deeply grooved, as in Crag specimens, the grooving being strongly marked below, and disappearing towards the apices of the ridges. Hence a corresponding difference in the edging of the enamel-plates, according to the stage of detrition. This specimen is very ferruginous, and might pass for a 'Crag' fossil. The dimensions are :—

Length of crown, 4·7 in. Width at first ridge, 1·5 in. Width at fifth ridge, 1·85 in. Height of enamel-plate at fifth ridge, 2·3 in.

Another smaller-sized detached specimen of the same tooth shows only seven principal ridges, with front and back talons, proving that there may be a difference of one ridge, more or less, in the ridge-formula of the last lower milk molar. Taking the data furnished by the young jaws, upper and lower, and using x as a symbol for the talons, the 'ridge-formula' of the milk-series in *E.* (*Loxod.*) *meridionalis* is proved to be thus :—

Milk molars.

$$\frac{x3x + x6x + x8x}{x3x + x6x + x8x}.$$

This specimen is also very ferruginous and 'Crag'-looking.

d. *Lower True Molars.*—The antepenultimate true molar is represented by a finely preserved detached tooth of the right side, having the crown and fangs complete. It presents eight ridges, with the usual talons. The large undivided anterior fang supports two ridges, and the anterior end bears the pit of pressure against the preceding tooth, proving the crown to be entire. The first four ridges are worn low, exhibiting thick enamel-plates, more or less grooved or channelled exteriorly, and thus presenting a spurious appearance of crimping, but unplaited, on the inner border. The disc is but slightly expanded in the middle, and without angularity. The last three ridges have only the tips of the digitations abraded, showing very distinct rings of thick enamel, free from grooving or plaiting. The ridges are all well in relief from the cement, and wide apart. The fangs supporting the last four ridges are confluent into a common shell. The principal dimensions are :—

Length of crown, 5·5 in. Width of ditto at second ridge, 2·25 in. Width of ditto at seventh ridge, 2·6 in. Height of crown at seventh ridge, 2·3 in.

This tooth, though of larger dimensions and with a much greater relative width than the last milk molar, retains the same number of plates.

The same tooth is presented *in situ*, in a mutilated left ramus of the lower jaw, containing the last milk molar worn low, and the antepenultimate true molar nearly intact. Like the specimen described, the crown is composed of eight principal ridges, with talons. The anterior talon and three front ridges are a little worn, the others entire. The specimen is red and ferruginous, like molars from the 'Crag.' The dimensions are :—

Length of crown, 6·4 in. Width of ditto at first ridge, 2·4 in. Height of fifth ridge, 4·0 in.

The penultimate or second true molar (fifth in antero-posterior succession, and third of the 'intermediate' molars) of the lower jaw, is well shown by a detached tooth of the left side, the crown and fangs of which are complete. It presents nine principal ridges, followed by a smaller tenth, and a talon-splent behind, so that it is open to regard it as having nine main ridges, with a front and complicated rear talon, or as having ten with a small talon. All the ridges are more or less worn. The tooth, in all its leading characters, so closely resembles the others already described, except in the implied condition of larger size, that it is unnecessary to describe the crown in detail. The wide separation of the ridges, ample width of the discs of wear, thickness of the enamel-plates, and their freedom from pli-

cation, are exactly as in the other teeth. In the central discs there is a tendency to an annular expansion or loop, which is directed backwards. In this specimen, also, the two first ridges are supported on a single fang, and the posterior ridges on a shell of confluent fangs. The dimensions are:—

Length of crown, 7·8 in. Width of ditto in front, 2·2 in. Width of ditto at the seventh ridge, 3·3 in.

The same tooth is presented in numerous fragments of the lower jaw, but, in most instances, more or less mutilated or worn out, so as to be less adapted for a distinctive description in reference to the ridge-formula.

Of the third or last lower true molar detached specimens are numerous in the Florentine Museum, besides a quantity of lower jaws containing it *in situ*.

One mutilated mandibular fragment of the left ramus contains the entire tooth, but not of the largest size, and probably of a female. The crown presents thirteen ridges, with a talon in front and a small talon behind. Of these, the anterior ten ridges are more or less worn—the first three into a continuous disc; the fourth, fifth, and sixth show a tendency to annular expansion (an outlying denticle) in the middle, the loop of enamel being invariably appended to the posterior plate of enamel. The seventh, eighth, and ninth ridges have each about six distinct roundish discs, indicating the same number of massive digitations, with very thick enamel. The tooth contracts very much behind. In all respects the discs of wear agree with those of the other teeth already described. The dimensions are:—

Extreme length of the crown, 10·25 in. Width of ditto at second ridge, 2·7 in. Width at third ridge where widest, 3·3 in. Width at eighth ridge, 3·0 in.

The summits of the worn plates of enamel, in this specimen, are remarkable for projecting about $\frac{1}{10}$ths of an inch above the cement; and, as usual (for the reason already given), the salient machærides recline towards the talon.

A very remarkable detached last lower molar, right side, in which the grinding-surface is somewhat contorted (as described of *E. priscus*, *antea*, p. 102), presents the unusual number of fifteen ridges to the crown, with a complicated talon. The large anterior fang and part of the first ridge are broken off. The tooth is singular in this respect, that although eleven of the ridges are worn, and the anterior ones low down, none of the discs are confluent across, the crown being traversed longitudinally by a deep fissure filled with cement, dividing it into two unequal portions, two-thirds belonging to the inner and one-third to the outer. Throughout

the crown there is a great tendency to distinctness in the digital processes. The cement in this specimen is in a great measure denuded. The plates of enamel project high above the level of the cement. The enamel is very black and highly rugous at the sides of the crown, with transverse wavy grooves. The dimensions are:—

Extreme length, 13·0 in. Width in front, about 4·0 in. Greatest width near the middle, 4·3 in. Greatest height of the plates behind, only 4·9 in.

From the abnormal characters of this molar, it cannot be safely taken for a guide as to the ridge-formula. The distortion of the crown may account for the unusual number of ridges. I have seen a still more remarkable case of similar malformation in a British fossil molar of *E.* (*Euelephas*) *antiquus.*

Another weathered or decomposed lower last molar of the right side is entire in front, but deficient in the posterior talon. The crown presents twelve ridges and a front talon. The enamel in this specimen is very thick and rugous. The dimensions are:—

Extreme length of crown, about 11·5 in. Width of the second ridge (enamel surface), 3·5 in. Width of the sixth, 3·7 in. Height of the eighth plate, 5·0 in.

The number of ridges in the last lower molar is inferred to vary from thirteen to fifteen. A similar but still greater variation is known to occur in all the species of *Euelephas*, and it in no respects throws uncertainty upon the constancy of the ridge-formula in the other teeth.

e. *Premolars.*—From the close affinity of the molar teeth in *E.* (*Loxodon*) *planifrons* and *E.* (*Loxodon*) *meridionalis* I instituted a close search in the latter for the premolar teeth, which are so remarkably developed in the former; but I could detect no indication of their presence. (See *antea*, p. 93.)

f. *Ridge-formula.*—Taking the data yielded by the preceding descriptions, and using x as a symbol for the talons, the ridge-formula of the true molars in *E.* (*Loxodon*) *meridionalis* appears to be thus:—

$$\frac{x8x + x(8\text{–}9)x + x13x}{x8x + x(8\text{–}9)x + (13\text{–}15)x},$$

and for the whole series, milk and permanent, rejecting talons:—

Milk molars.	True molars.
$\frac{3+6+8}{3+6+8}$:	$\frac{8+(8\text{–}9)+13}{8+(8\text{–}9)+13\text{–}15}$.

If this be compared with the ridge-formula of *E.* (*Loxodon*) *Africanus* and *E.* (*Loxodon*) *planifrons* (*antea*, pp. 90 & 91),

it will at once be perceived that they agree in the hypisomerous character of the intermediate molars, here indicated as distinctive of the group from *Euelephas*, the obvious difference being that, besides a greater number of plates in the last true molars, upper and lower, the cipher 8 prevails in *E. meridionalis*, and the cipher 7 in the others. In order to show how essentially distinct the Italian fossil species is in its molars from *E.* (*Euelephas*) *primigenius*, I may anticipate the results to be found in the sequel, so far as to contrast the ridge-formula of the true Mammoth,[1] viz.:—

Milk molars.	True molars.
$\dfrac{4+8+12}{4+8+12}$.	$\dfrac{12+(16\text{–}18)+24}{12+(16\text{–}18)+24\text{–}27}$.

For the manner in which this difference operates in modifying the form and relative proportions of the alternate layers of ivory, enamel, and cement, I may refer to the longitudinal and vertical sections of the molars, represented in fig. 1 of Pl. I., and fig. 5, Pl. II. of the 'Fauna Antiqua Sivalensis,' the former being of the Mammoth, the latter of *E.* (*Loxodon*) *planifrons*, in which the section closely resembles that of *E.* (*Loxodon*) *meridionalis*. (Reproduced in Pl. V. fig. 3 and Pl. IV. fig. 2 of vol. i.)

g. *Characters of the Tusks.*—In some of the crania the tusks are preserved entire; and the specimens are sufficiently abundant to furnish a correct idea of their form and direction. In one cranial fragment, comprising the united incisive bones, they are finely preserved in their natural position. In this case, the extruded portions diverge for some little distance in a straight line; they are then directed outwards, and curve gradually upwards and inwards, so that the points are closely approximated. When this incisive fragment is placed erect, the included area (between the tusks) gives a truncate, ovate, or lyrate outline, with the point towards the tips. Viewed sidewise, they appear to be produced forwards and upwards in a very gentle curve. On the whole, they do not differ much in this instance from varieties seen in the existing Indian Elephant. In the majority of cases they diverge, and are produced forwards and upwards in an easy curve, with the points directed outwards, very much as in the African Elephant, or in the skeleton of *Mastodon Ohioticus* in the British

[1] You will observe that this formula is very different from that of the existing Asiatic Elephant, and of the *Eueleph. antiquus* (the true one) of Chartres and Grays in Essex. The *E. meridionalis* formula is intermediate between *E. planifrons* and *E. Hysudricus*, but is nearest the latter, which it also closely resembles in the form of the cranium.—*Letter from Dr. F. to M. Lartet, Florence, July* 17, 1856. See also p. 176, *note.*—[Ed.]

Museum, figured by Owen.[1] They never present the pronounced arc, sometimes amounting to three-fourths of a circle, which is seen in large tusks of the Mammoth, nor the double or spiral curve so characteristic of the latter species. When attached to the cranium, they are often found in the matrix, lying flat, and curved horizontally outwards like a sickle, in the *Theristocaulodon*-fashion so grotesquely represented by Koch in his fanciful restorations of the North American *Mastodon*. This I believe to be an accident,[2] after the decomposition of the soft parts, from torsion of the tusks within their alveoli, in consequence of the excessive weight of the extruded portions. It occurs only in the largest specimens, and the tusks have been restored in this position in some of the crania in the Florentine Museum. In one enormous skull, a late acquisition, there is but a single tusk, on the right side. On the left, the alveolus is in a great measure filled up, but not withered, which would indicate that the left tusk had been lost late in life. The borders of the incisive sheaths, in this case, diverge widely apart and suddenly. In the Indian Elephant, the tusks are sometimes broken with prodigious violence in combats between savage males, and the fracture may take place either within or outside the alveolar sheaths. My colleague, Sir Proby Cautley, has witnessed an accident of the kind in an Elephant-fight at Kotah, in Central India.

The tusks attain an enormous size, commensurate with the colossal stature and bulk of this species. In a huge male cranium, having the zygomatic arches entire, they measure outside the incisive sheaths 24 inches in girth. A detached fragment of another tusk measures about 25½ inches; the section is nearly circular. A polished frustum of another yields upwards of 27 inches in girth, being an average diameter of 9 inches. The section varies between round and elliptical. In a finely preserved cranium, in which the tusks are entire, they measure 6 feet 9 inches, including the alveolar portion, with a diameter of 5 inches. Cuvier gives the dimensions of only a single Tuscan tusk, namely, 6 feet 8 inches long. A specimen of fossil tusk from Rome, presented to the Paris Gallery by the Duc de la Rochefoucault and M. Desmarets, measures fully 28 inches in girth (*vide* Cuv. Oss. Foss. tom. i. p. 173). It is probably of *E. meridionalis*.

In varieties of one of the living species, the tusks are known to vary so considerably in their contour and in direction that no absolute distinctive characters can safely be founded upon

[1] British Fossil Mammalia, p. 298, fig. 102.

[2] See the frontispiece and p. 88 of Warren's 'Mastodon giganteus,' Boston, 1852.

them. All that can be said of the Val d'Arno specimens is, that they are invariably without the double or spiral curvature and circular arc, with recurved points, which are so generally observable in the tusks of the Mammoth, and that they most resemble those of the African Elephant.

h. *Cranium.*—The characters yielded by the ridge-formula are so pronounced, and so distinctive of *E. meridionalis* from *E. primigenius*, that the inquiry is immediately suggested, 'Are they borne out by a corresponding amount of difference in the form of the cranium?' The reply is in the affirmative; but I cannot pretend to establish this part of the case with the precision and metrical proofs which I have endeavoured to adduce in regard to the teeth. This duty should devolve upon some of the anatomists or palæontologists of Italy. The time and means of access at the disposal of a mere traveller are unequal to the satisfactory accomplishment of a laborious task of this nature. But it is to be hoped that the desideratum will not continue long unfulfilled. In the remarks which follow, I shall combine the results of my own observations with those of Nesti, which I was enabled to verify at Florence, and with the avowal that they are to be considered more as a contribution 'pour servir' than as an exact or complete description of the subject.[1]

The following materials, in relation to the cranium, exist in the Museum at Florence:—

1. A very young cranium with the lower jaw attached, containing the earliest milk-teeth unworn. It is complete, but crushed. Nesti mentions that he had seen another fœtal cranium in the possession of Count Bardi.

[1] The Grand Dukes of Tuscany have long evinced the enlightened spirit of patronage of science and the liberal arts which was bequeathed to them by the illustrious Medici. But art-worship, and reverence of the relics of Galileo, have cast some branches of inquiry into the cold shade of disregard. The Grand Ducal Museum at Florence contains a collection of Mammalian remains from the Pliocene deposits of the Val d'Arno, unrivalled in Europe both for their abundance and for the perfect condition in which they are preserved. Elsewhere palæontologists are compelled to grope their way by the faint light of mutilated specimens; there the fossil remains of the same forms are presented entire. A good monograph, liberally illustrated, upon the fossil Mammalia of the Val d'Arno would reflect as bright a lustre on the Italian diadem as do the *chefs-d'œuvre* of the Tribune or the Galleries of the Palazzo Pitti. The patronage of the Court has been for centuries bestowed upon the wax-models of the Museum, but withheld from the magnificent fossil remains that are laid out under the same roof. Except a few and inadequate memoirs by Nesti, nothing worthy of the subject has been brought out in Italy upon these Tuscan collections during the last half century; and it is not overstating the fact to say that the progress of research on the extinct faunas of the Upper Tertiary formation in Europe has been retarded a quarter of a century in consequence. Had these collections been yielded either by Siberia or by the northern part of the valley of the Po, the general results would have been familiar knowledge long ago. At present, a journey to Florence is the only means of becoming acquainted with them.

2. Another very young cranial fragment, comprising both maxillaries, palate, milk molars on either side, and the lower jaw detached, in fine preservation.

3. The cranium C of Nesti's description,[1] and represented reversed in figs. 1 and 2 of his plate, copied in outline in figs. 19 of Pls. XLII. and XLIV. of the 'Fauna Antiqua Sivalensis,' under the misnomer of *E. antiquus*. It is nearly perfect in the frontal and occipital regions, condyles, maxillaries, and molars, but imperfect in the facial portion, the border of the nasal opening being broken, together with the terminal portion of the incisive alveoli and the zygomatic arches. Since Nesti's figures were taken, this specimen has suffered considerable damage, the upper lamina of the right incisive alveolus having disappeared, together with the salient tip of the nasals and the lateral margin including the left orbit. The last molar is present on either side, far advanced in wear. (See Pl. I. fig. 11, and Pl. II. fig. 16.)

4. The cranium A of Nesti's references, fig. 3, comprising the palatine, maxillary, and temporal regions, the inferior part of the occiput, and the zygomatic arches, the only deficiency being in the facial region. The specimen, which is highly ferruginous, has now joined on to it the entire incisive sheaths (not represented in Nesti's figure) and two enormous tusks, which are spread out horizontally in the *Theristocaulodon*-manner above noticed. Nesti, in his memoir, cites the tusks of this specimen as yielding a diameter of $0{\cdot}26^{m}$, or 10·2 inches. The last molar, much worn, is present on either side.

5. Fragments of a cranium of colossal dimensions, comprising, besides unjoined pieces, the maxillaries, palate, and the last molar on either side, with the incisive bones entire, and of enormous size. They form a plane, at the distal end, of fully a mètre in width (Nesti), or 39½ inches. The incisive alveoli diverge at their extremity, and contract very considerably upwards. This is cranium B of Nesti's references, unfigured. The tusks in this specimen, according to Nesti, are only 0·19 , or 7½ inches in diameter, and the molar is 11 inches long.

6. A skull, with very old molars, and the entire incisive sheaths, together with the tusks finely preserved in their natural position.

7. A cranium, mutilated as regards the incisive bones and zygomatic arches, with large tusks and much-worn molars; very white in its mineral condition.

[1] Lettere sopra alcune ossa fossili del Val d'Arno non per anco descritte sulla nuova specie dell' Elefante (*E. meridionalis*) fossile del Val d'Arno. Pisa, 1825–6.

8. A cranium nearly entire, attached to the mounted trunk, with the incisive sheaths very long, perfect, parallel, and containing moderate-sized tusks. The upper and lower jaws of this specimen were fixed in apposition, concealing the crowns of the molars; and I am unable to say, with confidence, that it belongs to *E.* (*Loxod.*) *meridionalis*.

9. A fragment, comprising the incisive alveoli, with the perfect tusks in their natural position and of moderate dimensions.

Viewed from the front aspect, the head is more depressed, and wider behind the temporal fossæ, and the length of brow from the vertex to the tip of the nasals is markedly less in *E. meridionalis* than in *E. primigenius*. In the latter, the frontal region between the margins of the temporal ridges is broad; in the former it is much narrower, being encroached upon by the temporal fossæ. The bounding ridges sweep round by a bold curve into the post-orbitary processes in *E. meridionalis*, somewhat in the manner represented in the cranium of *E.* (*Stegod.*) *bombifrons* (Fauna Antiqua Sivalensis, Pl. XLIII. fig. 13), in which the fronto-parietal region is much constricted, while in *E. primigenius* they pass into the post-orbitary processes by a gentle sigmoid flexure. (See Pl. I. figs. 6 and 15.)

In the Indian Elephant the posterior border of the vertex is deeply emarginated by a re-entering sinus, corresponding with the upper termination of the occipital fossa; in *E. meridionalis* the line is transverse, the fossa being overarched by a produced fold of the vertex (*vide* Nesti, *op. cit.*, and Pl. I. fig. 11).

The posterior orbitary process is very pointed and hooked; the lachrymal tubercle is also pointed, while in *E. primigenius* it is thick and prominent.

The nasals are salient, and terminate in an obtuse point; they show no tendency to becoming lunately bifid as in the African Elephant (Pl. I. fig. 10).

The nasal aperture is situated considerably nearer the vertex in *E. meridionalis* than in *E. primigenius*; the bounding margin presents a reniform outline with the cornua directed forwards, as in the latter and in *E.* (*Euelephas*) *Hysudricus* (Pl. I. fig 12).

In *E. primigenius* the incisive alveoli are very much elongated and parallel. The general plane of their upper surface meets the plane of the frontal at a slight angle, from the alveoli being a little inflected towards the molars. This involves a corresponding modification in the symphysis of the mandible, the diasteme descending nearly vertically, to terminate in a short pointed beak. An equally remarkable elongation of

the incisive alveoli is presented by Colonel Baker's huge cranium in the British Museum, of the form named *E.* (*Stegodon*) *Ganesa* in the 'Fauna Antiqua Sivalensis.' If the outline-profile (Pl. II. fig. 12) of this species be compared with that of the Mammoth (fig. 20), it will be seen that the plane of the incisives in the former is continuous with that of the frontal, with a tendency to obliquity forwards. The alveoli are parallel in this form, as in the Mammoth.

In *E. meridionalis* the incisive alveoli are also much elongated; but, instead of being parallel, in all the large crania they diverge from the sub-orbitary foramina on to their extremity, where the divergence becomes sudden and as marked as in the African Elephant.

In the huge cranium No. 5 of the enumeration above, the width of the incisive bones at their distal end reaches the enormous spread of 39½ inches (Nesti). The inter-alveolar fossa, deep below the nasal aperture, soon becomes shallow and disappears entirely near the extremity of the bones, where an osseous plateau is interposed between the alveoli. This divergence of the incisive sheaths is seen in the Florentine specimen, represented by Cuvier in fig. 2 of Pl. IX. of the Elephants, in the 'Ossemens Fossiles.' In the Mammoth they are parallel and approximated, with an interposed fossa, throughout.

The only exception to the character here indicated that I observed in the Museum of Florence is presented by the cranium No. 9 of the above list, in which the tusks are comparatively small, indicating a female, and the specific identity of which was not well determined. In it the incisive sheaths are long, and, if not parallel, they are but slightly divergent, although more dilated than in the Mammoth.

a. Lateral aspect.—When the head is rested on the plane of the molars, and regarded sidewise, the following points are observable:—

1. The short extent and concave arc of the surface between the vertex and the point of the nasal bones. In *E. primigenius* the brow is also concave; but the curve is gentle and distributed over a long surface, whereas in *E. meridionalis* it is shorter and more pronounced. The concavity is much greater than is represented in fig. 16 of Pl. II., copied from Nesti's side-view of cranium No. 3 of the list, and it is still more pronounced in cranium No. 4, in which it approaches the concave arc presented by *E.* (*Euelephas*) *Hysudricus* (fig. 17 of Pl. II.) The upper occipital plane, as defined by the outline of the occipital bosses, meets the frontal plane nearly at a right angle, while the lower occipital plane joins on with the former at an open angle, somewhat resembling

the profile-view of the skull of *E. Africanus* (fig. 15, Plate II.).

2. According to Nesti, the plane of the zygomatic arch is inclined to that of the molars at an angle of about 35°, while the two planes are nearly parallel in *E. primigenius*. In *E. meridionalis* they are also more elongated.

3. The antero-posterior extent of the temporal fossa, in relation to its vertical height, increases progressively from *E. primigenius* through *E. Indicus* to *E. Africanus*, being round in the latter and oval in the Indian Elephant. In *E. meridionalis* the temporal fossa has a large antero-posterior expanse. According to Nesti, the proportions of length to height are in the Indian Elephant as 37 : 44, while in *E. meridionalis* they are as 16 : 17. The difference is still greater when the latter is compared with *E. primigenius*.

4. Corresponding with these proportions, the distance from the auditory meatus to the nasal border is greater, and from the same point to the vertex less, in *E. meridionalis* than in the Mammoth.

5. The incisive alveoli form elongated massive cylinders corresponding with the huge diameters of the tusks, but instead of forming an angle with the frontal plane, as in *E. primigenius*, they are produced in the same plane, or with a little outward obliquity, in *E. meridionalis*.

β. Occipital aspect.—The occipital face is chiefly remarkable for two enormous bosses stretching from a little way above the condyles up to the vertex, and leaving between them a long and deep depression for the attachment of the ligamentum nuchæ and muscles of the neck. These bosses are continued on either side into the protuberant arches of the parietals, that bound the temporal fossæ towards the vertex. Nesti describes them as 'grassi tetrædri,' with parallel faces where separated by the fossa, and as pointed towards the condyles. He regarded the spacious deep fossa as a distinctive mark from *E. primigenius*. But Breyne, in his excellent description of Messrs. Schmidt's cranium of the Mammoth,[1] expressly states that there is 'a peculiar and very remarkable sinus of the occipital bone, deeper than an ostrich's egg, serving in all appearance for the insertion of the muscles of the neck.' These occipital bosses are distinctly represented by two convex lines in Breyne's profile figure, one of which is omitted in the copy reproduced by Cuvier.[2] Their development varies in the Elephants, according to the age, sex, and size of the tusks in the individual. In some of the species, such as *E. Namadicus* and *E. Hysudricus*, the fossa

[1] Phil. Trans. vol. xliv. for 1737-38, p. 133.
[2] Oss. Foss. tom. i. *Éléphans*, Pl. ii. fig. 1.

terminates upwards in a deep concave notch of the vertex. In *E. meridionalis*, and also in a less degree in *E. primigenius*, it is overarched by a produced lamina of the vertex. I am unable to give any details as to the extent of the sphenoid alæ in the Italian form.

γ. *Basal aspect.*—One of the distinctive characters of the Mammoth, upon which Cuvier laid much stress, is the parallelism of the molars in the upper jaw. In *E. meridionalis*, young and old, they invariably converge, more or less, in front. In young specimens this convergence is very pronounced; in the worn-out molars of very old crania it is less obvious. It is distinctively shown in the palate-specimen, fig. 1 of Plate VI. of Cortesi's cranium, from Monte Pulgnasco.

The materials for comparative description of the crania of the Elephants have been largely increased since the time of Cuvier, and chiefly with the skulls of Indian fossil species. The points here indicated clearly show that the cranium of *E. meridionalis* differs more from that of the Mammoth than does the latter from the existing Indian Elephant. The Italian form, in this respect, resembles most the cranium of *E. Hysudricus* from the Sewalik hills, and is intermediate between it and that of the African Elephant, although widely different from both.

i. *Lower Jaw.*—Much importance was attached by Cuvier to the form of the mandible as distinctive of the Mammoth; and to that of *E. meridionalis* by Nesti. I have already adverted to the error committed by the latter (pp. 42, 81, and 105) in taking the lower jaw of *M. Arvernensis* as the type of his *E. meridionalis*. He adhered to this opinion to the last, notwithstanding the correction by Cuvier. The demonstration is so manifest that it would be unnecessary to discuss the point again, but that De Blainville has reproduced Nesti's figure in the 'Ostéographie,' with the designation of *E. meridionalis*, thus sanctioning it in some measure with his authority.

In *Mastodon Arvernensis* the horizontal ramus anteriorly bulges out with great convexity, and the symphysial beak is projected forwards with very little inclination of the diastemal ridges, and not as a continuation of the lower margin of the ramus, which is rounded off and curved upwards to join the beak. The latter is raised considerably above the level of the lower margin, which is convex in the antero-posterior direction. The beak forms a short, blunt, dilated spout, with raised diastemal margins. On the contrary, in all the known Elephants of the groups *Loxodon* and *Euelephas*, the beak of the symphysis is a prolongation of the inferior margin, into

which the diastemal ridges descend with great obliquity; and it is attenuated towards the apex to terminate in an obtuse point (*vide* Faun. Antiq. Sival., Pl. XIII. B. figs. 1–8). The original of Nesti's figure yields all these distinctive marks of *Mastodon* in a very pronounced manner, and it is demonstrable that the beak is incompatible with the ascertained direction of the incisive bones and tusks of the upper jaw in *E. meridionalis*.

Of the numerous rami of the lower jaw, young and old, of this species in the Florentine Museum, the most perfect is an entire mandible attached to the cranium No. 8 of the above enumeration. There are other specimens of a much larger size. On the comparison of several, the following characters were yielded :—

1. The teeth of the opposite sides converge in front, instead of being nearly parallel, or but little inclined, as in *E. primigenius*.

Much stress was laid upon this character by Cuvier in his description of the Mammoth; but it is assuredly neither absolute nor constant. In proof of this I may refer to figs. 1, 2, and 3 of Pl. XIII. A. 'Fauna Antiq. Sival.,' or to fig. 1 of Pl. I. of Fossil Remains in the 'Voyage of the Blossom,' in all of which the opposite lines of molars are more or less convergent.

2. The length of the alveolar margin, from the anterior edge of the ascending ramus to the commencement of the diasteme, and the entire length of the horizontal ramus, both absolutely and relatively to the breadth of the ascending ramus, are greater in *E. meridionalis* than in *E. primigenius*.

3. In the Mammoth the rami meet in front by a very obtuse and rounded curve, from which a short, deflected, and contracted beak is suddenly given off; in *E. meridionalis* they unite by the curve of a flattened ellipse, and the symphysial beak is given off by a broader base and less suddenly.

This obtuse and rounded outline in the Mammoth was much insisted upon by Cuvier. It is constant and very distinctive of the species. The figures above cited may be referred to.

4. In *E. primigenius* the horizontal ramus attains a great elevation in front, from which the diastemal ridges descend nearly vertically, or with an abrupt inclination, into the short beak: in *E. meridionalis* the ramus is longer, and proportionally less elevated in front, and the diastemal margins slope gradually into the symphysial beak from a broader base; the apophysis is produced more in front, and is larger in all its dimensions than in *E. primigenius*. The symphysis is in consequence longer in *E. meridionalis*. In the perfect man-

dible of No. 8, the distance from the posterior surface of the symphysis to the apex of the beak-apophysis measures $6\frac{1}{2}$ inches.

5. Viewed sidewise, when the lower jaw of the last specimen is placed so as to rest on the posterior part of the ramus and on the symphysis (exclusive of the beak), the inferior margin presents a well-marked concave arc, and the beak is produced forwards and downwards, for a considerable extent below the plane upon which the symphysis rests. It attenuates to a fine emarginate point. This concavity of the lower border and the gradual slope of the diastemal ridges into the beak are well seen in the young lower jaw which yielded the description of the earliest milk molars. The latter character is also finely exhibited by a superb British specimen from the Elephant-bed at Happisburgh, in the Rev. John Gunn's rich collection at Irstead; and in the Val d'Arno specimen in Dr. Buckland's collection, represented by figs. 10 and 10 *a* of Pl. XIV. B. of the 'Fauna Antiqua,' in which, although mutilated, the long symphysis and gradual inclination of the diasteme are well marked. There is no good published figure of the lower jaw of this species which can be referred to for a visual appreciation of these differences. But an approximate idea may be had by comparing the outline of figs. 1, 2, and 3 of Pl. XIII. A. and XIII. B. of the 'Fauna Antiqua Sivalensis,' representing different ages of *E. primigenius*, with that of fig. 7, representing the lower jaw of *E. Hysudricus*, which is allied in form to *E. meridionalis*; or fig. 4 of Pl. V. in the 'Ossemens Fossiles' of the Mammoth, with fig. 8 of Pl. IX., a Romagnano specimen of *E. meridionalis*. A very characteristic representation of the lower jaw of an old Mammoth, by Scharf, is given in Buckland's Appendix to the 'Voyage of the Blossom,' fig. 1 of Pl. I., above referred to.

k. *Summary of the Characters.*—On a review of the characters detailed in the preceding descriptions, it follows that in all the points connected with the form of the cranium, teeth, and lower jaw, upon which the great French anatomist rested his distinctions among the Elephants, recent or fossil, *E.* (*Loxod.*) *meridionalis* differs essentially from the Mammoth, strictly so called. They have only two characters in common, namely—1st, the great width of the crowns of the molars; 2nd, the long alveoli of the tusks. But in the former species the height of the molar crowns is low; the ridges are cuneiform in their vertical section and limited in number, with thick enamel; and the incisive alveoli are divergent, with simply curved tusks; in the latter the height of the molar crowns is excessive, the ridges very numerous, attenuated,

and closely packed together, with thin unplaited enamel; and the incisive alveoli are parallel, approximated and inflected; the tusks are spirally recurved. It will be seen in the sequel that, so far from being nearly allied forms, there are several species interposed between them.

It is no part of the design of this essay to describe the osteography of the species more than may be subservient to their ready discrimination when found fossil. I shall therefore reserve any remarks upon the peculiarities of the bones of the trunk and extremities in the Italian form for the illustration of British specimens. Bones of colossal dimensions abound in the Museum at Florence; and Cuvier inferred from remains in the Paris Museum that the fossil Elephant of Monte Serbaro, here referred to *E. meridionalis*, attained a height of at least fifteen feet.

B. *British Specimens.*—The copious details already given regarding the dentition of this species relieve me from the necessity of minutely describing a great variety of the British specimens. Having the certainty, from such cumulative evidence abroad, of the distinctness of the species, it will suffice to show where the same form occurs in England, in what strata, under what circumstances, with what associates, and where it is wanting. I shall refer only to such characteristic instances as place the specific identity of the fossils beyond question, and as are accessible for comparison.

The finest British collection of the remains of this species with which I am acquainted has been gradually accumulated during the last thirty years by the Rev. J. Gunn, of Irstead, from sections along the Norfolk coast. The vast abundance in which Elephants' teeth occur upon the 'Oyster-bed' of Happisburgh and Mundesley has been long known.[1] Mr. Gunn, favourably situated to benefit by such opportunities, has taken advantage of his position to the full measure. The interest and value of his collection are only equalled by the liberality with which he makes it available for the ends of science. I need only say in illustration that he has placed all the specimens in his possession at my disposal, for this essay, even to be sawn up for sections, if necessary, or for any other use to which they could be turned. Besides a great number of detached molars, Mr. Gunn possesses huge bones of the extremities, an enormous pelvis, and lower jaws,

[1] Periodic storms, during winter, scour the beach and undermine the cliffs, causing slips. When the detritus is washed away, Mammalian remains are left in abundance upon the shore. The scouring action of the storm-waves, at times, tears up masses of the 'submarine forest' and of the 'Elephant-bed,' in the latter of which the Elephantine remains occur best preserved and in the greatest abundance.

which are only second in preservation to the Val d'Arno specimens.

In the Norwich Museum there is also a fine series of Elephant molars from the 'Crag' and various points of the coast section, including both *E. meridionalis* and *E.* (*Euelephas*) *antiquus.* The richness of the late Miss Anna Gurney's collection in Elephant remains is well known; and some very fine specimens from the 'Crag' are in the possession of Mr. Robert Fitch, of Norwich. With a single exception, up to the present time I have not seen a fragment referable to *E. meridionalis* that has not been derived either from Norfolk or Suffolk.

a. *Molars.*—In the following descriptions of the teeth I do not consider it necessary to follow the strict order hitherto observed of upper and lower, milk and true molars, according to their respective succession. I shall take the most characteristic specimens first.

The finest detached molar of this species that has come under my observation is a specimen which was discovered in the 'Mammaliferous Crag' on the Thorpe road, near Norwich, by Mr. Prestwich. The authority of so eminent and accurate a geologist is a sufficient guarantee for the locality and the formation. It is now lodged in the Museum at Norwich, and is the specimen which first convinced me many years ago that the 'Crag' yielded a species of Elephant entirely distinct from the Mammoth and from *E. antiquus.* It is represented, one-third of the natural size, by figs. 18 and 18 *a* of Pl. XIV. B., under the misnomer already explained, of *Elephas antiquus*, in the 'Fauna Antiqua Sivalensis.' It is the last true molar, lower jaw, right side, showing eleven principal ridges, an anterior talon, and a back talon limited to a single thick digitation. The first five ridges are slightly worn, the rest being intact. The fangs are broken off, but the definition of the anterior large fang is distinctly traceable. The cement over the surface generally has been decomposed or denuded, and is replaced by a crust of Crag matrix, of a very rusty appearance, filling the interspaces. The anterior talon thins off from the outside inwards, and is considerably narrower than the first ridge, of which the inner edge is broken. The apices of the ridges, from the second to the fifth inclusive, are all more or less fractured, and the digitations present very thick enamel. The sixth, seventh, and eighth ridges show each about four thick digitations; the ninth and tenth, from four to five converging; and the eleventh, four digitations, the innermost of which is fractured. The definition of the base of the crown behind is a little damaged, but nothing is wanting.

The dimensions are:—

Extreme length of crown, 11·25 in. Width of crown in front, 3·3 in. Width at fifth ridge, where the crown is broadest, 3·8 in. Extreme height of ridges, where the crown is broadest, 4·8 in. Width of ninth ridge, 3·5 in. Height of ninth ridge, 4·6 in.

From these dimensions it is apparent that, in a length of 11¼ inches, there are eleven ridges, with talons, and the seven ridges from the fourth to the tenth inclusive, measured along the inner wall of the crown, yield a length of fully 7 inches, being an average of one plate to an inch, and fully equal to the expansion of the ridges in the African Elephant or in *E. (Loxodon) planifrons*. The terminal divisions of the ridges form stout irregular cylinders, as thick as the little finger, while in the Mammoth they are more slender and quill-shaped. The digital lobes of the ridges in *E. meridionalis* are so massive and distinct that they have occasionally been figured and described as being of *Mastodon*. The specimen now in the Norwich Museum, composed of two ridges, from the Crag of Bramerton, described by Woodward,[1] is of this nature. The enamel is very thick. I have in no case attempted to express this in figures, as the plates are so ragged and unequal that any linear measurement would be deceptive; but it is very obvious to the eye; and when the teeth are sawn up and polished, their distinctness is strongly marked. The surface of the enamel in this specimen is excessively rugous from transverse, wavy, parallel wrinkles, as in the Italian specimens. (See Plate VIII. fig. 1.)

A Val d'Arno lower molar of the same age, from Dr. Buckland's collection in the Oxford Museum, is represented, crown side, by figs. 17 and 17 *a* of the same plate. The dimensions of this specimen are:—

Length of crown, 10 in. Width of crown, 3 4 in. Height of crown, 5 in.

It presents eleven principal ridges, with front and back talons. The English and Italian specimens agree so entirely in their general aspect and relative proportions, that it suffices to compare the figures to be convinced that they belong to the same species, the only difference being that the latter has the ridges divided into a greater number of digital terminations—a circumstance of trivial importance, and liable to much variation. (See Plate VIII. figs. 2 & 3.)

If, on the other hand, the last lower molar of *E. primigenius* be compared with the 'Crag' specimen, it will be found to comprise, in a length of 13 inches, from twenty-four to twenty-seven closely packed ridges, with all the dental materials attenuated, the enamel especially thin; so that when

[1] Mag. of Nat. History, 1836, vol. ix. p. 154, figs. 2, 3, *a* and *b*.

sawn up vertically, the section presents an appearance closely resembling the teeth of a comb. (See Pl. V. fig. 3 of vol. i.)

The Crag molar from the Thorpe road is so conclusive, that, had no other specimen been met with, it would of itself have sufficed to establish the existence of *E. meridionalis* in the fossil state in England.

A superb right ramus of the lower jaw, in the Gunn collection, dug out of the Elephant-bed between Mundesley and Bacton, presents the penultimate and last true molars *in situ*, the former half worn out and exhibiting four partly confluent discs of wear; the latter having the first five ridges and talon worn, the rest covered with cement, and partly embedded in the angle of the jaw. It comprises about thirteen ridges, exclusive of talons. The posterior ridges are not distinctly shown, in consequence of the coat of cement. In the penultimate, the discs of the last two ridges are confluent by a narrow isthmus of ivory, and they exhibit a mesial angular expansion, resembling very much that of *E. (Loxod.) priscus*. But this is simply an accident of age, from the very low stage to which the wear of the crown has been carried, close to the common base of ivory.

Of the last molar, the anterior talon is very broad at the outer side, and contracts inwards. The first four ridges exhibit wide discs, bounded by an irregularly flexuous plate of very thick enamel. The fifth ridge shows the apices of about six very thick and distinct digitations. Between the fourth and fifth ridges, but appended to the *posterior* margin of the former, there is a single outlying mesial digitation. The crown of this tooth is distinguished by its massive character and width.

The dimensions are:—

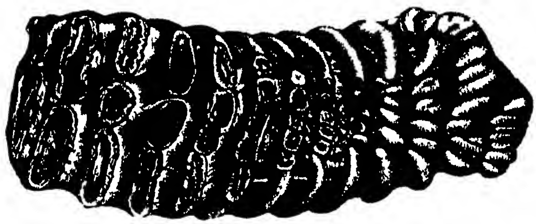
Length of remains of penultimate, 3·6 in. Width of crown of penultimate, approximatively, 3·2 in. Length of the crown of last molar, 10·0 in. Greatest width of the crown at the fifth ridge, 3·9 in.

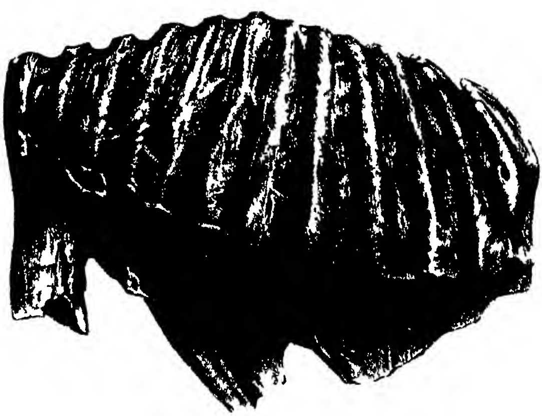
The last tooth is markedly curved in its antero-posterior direction, the inner side being convex, the outer concave.

Another important specimen in the Gunn collection is a detached fragment comprising the posterior half of the last lower molar, left side, showing seven ridges and the posterior talon. It is inferred that from four to six anterior ridges with the front talon are wanting. The first three ridges are slightly worn, presenting distinct annular discs, surrounded by a margin of thick enamel. Each of these ridges presents about five digitations converging upwards. The specimen, through its deficiency in front, is well adapted for showing one of the most distinctive characters of the species, namely, the low height of the ridges relatively to the breadth of the

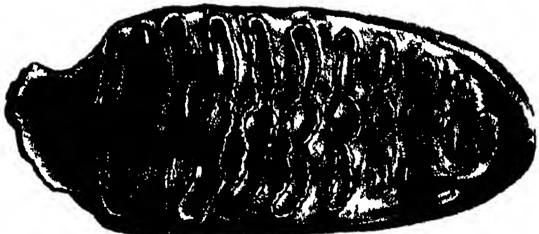
Fig 1

Fig





Fig



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Elephas (Loxodon) meridionalis

crown. The fracture in front passes vertically through a ridge, exhibiting the angle of reflexion of the enamel-plate. The extreme height of the fourth ridge of the fragment is 4·5 inches, while the extreme width of the crown is 4·1 inches. The height of the crown is thus seen to exceed the width by barely half an inch. The proportions in *E.* (*Eueleph.*) *antiquus* and *E.* (*Eueleph.*) *primigenius*, as will be seen in the sequel, are very different. A longitudinal section of this specimen has been made, which exhibits very perfectly the relative proportions of the ivory, enamel, and cement, together with the cuneiform character of the ivory-core of each ridge. It is highly desirable that it should be figured of the natural size, for the guidance of English collectors in discriminating teeth of this species.

The principal dimensions are:—

Length of the fragment, 7·5 in. Width of crown at the section, 3·8 in. Height of front plate of enamel, 3·9 in. Width of crown at third ridge, 4·1 in. Height of enamel-plate of fourth ridge, 4·5 in.

This specimen bears such a close resemblance to the corresponding tooth of the Indian fossil species, *E.* (*Loxod.*) *planifrons*, that I question if these teeth of the two forms, in the same mineral condition, could be distinguished if found mixed in a collection.

The Irstead collection (Gunn's) contains numerous other molar teeth or fragments of *E. meridionalis*, from Bacton, Mundesley, Horsea, and Happisburgh, which have not been figured; and I, therefore, do not think it necessary to describe them on the present occasion: some of them, it is to be hoped, may appear shortly elsewhere.

The other illustrations of the species, to be noticed in the sequel, are chiefly from specimens in the Norwich Museum, which were liberally transmitted to London for identification by the managers of that excellent institution, and are figured in the 'Fauna Antiqua Sivalensis,' Pl. XIV. B. The citations which follow all refer to that plate, in which the figures are drawn to one-third of the natural size.

Figs. 1 and 1 *a* represent the plan and side-view of the penultimate or second upper milk-molar of *E. meridionalis*. It is a germ-specimen, without fangs, and a good deal rolled. The crown is composed of six principal ridges, besides front and back talons. It was compared with the corresponding tooth of *E.* (*Loxodon*) *planifrons*, which it resembles very closely, but it has a broader crown.

The dimensions are:—

Length, 2·6 in. Width of crown at first plate, 1·15 in. Width of crown behind, 1·4 in. Height of crown at fifth ridge, 1·55 in.

The corresponding tooth of *E.* (*Eueleph.*) *antiquus* and of *E. primigenius* yields normally eight transverse plates. The precise origin of the specimen is not recorded; but it is supposed to have belonged to Mr. Samuel Woodward, and to have been derived from the Norfolk coast.

The specimen fig. 2 and 2 *a* is another example of the same tooth, a penultimate upper milk molar, right side, discovered in the Norwich Crag at Easton, Suffolk, by Captain Alexander. It presents six ridges, well advanced in wear.

The dimensions are:—

Length, 2 4 in. Width in front, 1·0 in. Width behind, 1·6 in.

Figs. 3 and 3 *a* represent another well-worn penultimate milk molar, probably of the lower (?) jaw, right side. It is of a larger size than the others, but shows the same number of plates, namely six, with talons. It is very broad in the crown relatively to the length. The discs of the ridges are very wide, like the Italian specimens. This molar belonged to the collection of Mr. Samuel Woodward; it is now in the Norwich Museum. It is heavy and dark-coloured, and bears fresh patches of marine incrustation,[1] and may have come from the 'Oyster-bed' of Mundesley and Happisburgh.

Figs. 4 and 4 *a* represent the last milk molar of the lower jaw, left side. The crown is worn, and comprises eight ridges. The ends and sides of the crown are partly injured. In mineral condition it is black and heavy, but free from patches of marine incrustation. It is supposed by Mr. Samuel Woodward to have been procured from the coast (Norwich Museum).

The dimensions are:—

Length of crown, 3·9 in. Width of crown in front, 1·4 in. Width of crown at sixth ridge, 2·0 in. Height of crown at seventh ridge, 2·1 in.

The ridge-formula in these specimens yields the same ciphers as were found to hold in the Italian specimens; and they agree in the other characters of a broad crown, with low ridges and thick plates of enamel.

Figs. 5 and 5 *a* represent a finely preserved entire specimen of the antepenultimate or first true molar, lower jaw, left

[1] In this and the following descriptions the term 'marine incrustation' means recent patches of existing Polyzoa, two of which have been determined by Mr. Busk to be species of *Lepralia*, or of other allied forms. Their presence determines the fossils to have been dredged out of the modern sea-bottom. This is a point of some importance in the present case, since the Mammalian contents of the 'clay-beds' have been so heedlessly regarded in the geological descriptions of the Norfolk coast, that there is hardly on record a single instance of a Mammal remain precisely referred to any one distinct stratum above the 'Elephant-bed' of Gunn, although the fossils, in many instances, bear palpable indications of the matrix in which they were embedded.

side, composed of eight principal ridges, with front and back talons. The six anterior ridges are worn. The discs of the first three ridges are wide and open, but irregularly indented, with a tendency to mesial expansion, and surrounded by margins of thick enamel, which is vertically channeled externally and slightly crimped; the posterior ridges show the apices of six or seven digitations; the interspaces filled with cement between the ridges are open, and the ridges are well apart.

The dimensions are:—

Length of crown, 5·3 in. Width in front, 1·6 in. Width behind, 2·3 in. Height of the seventh plate, 2·5 in.

One of the distinctive characters of the species, namely, the low height of the crown in reference to the breadth, is well exhibited. The specimen is dark-coloured and heavy, from ferruginous infiltration. It was discovered at Mundesley, and belonged to Mr. S. Woodward (Norwich Museum).

Another left lower antepenultimate true molar of a larger individual, and more advanced in wear, is represented by figs. 6 and 6 *a*. The crown presents a front talon and eight ridges, all of them worn; the discs are wide and open, and the vallicular interspaces are also wide; the enamel-edges are thick, and in some of the plates disposed to slight crimping, with irregular angular expansion. The annular discs of the seventh ridge are of large size. This tooth bears the large anterior fang. It is a very characteristic specimen of *E. meridionalis*.

The dimensions are:—

Length of crown, 5·5 in. Width of crown at second ridge, 2·2 in. Width of crown behind, 2·65 in. Height of crown at seventh ridge, barely worn, 2·0 in.

The specimen is hard, heavy, and dark-coloured, and is marked as having come from Mundesley (Norwich Museum).

Figs. 7 and 7 *a* represent a fragment, comprising the anterior two-thirds of the penultimate or second true molar of the lower jaw, right side. It includes seven worn ridges. The discs of wear are wide, and separated by broad bands of cement; the rings of the digitations are large; the plates of enamel are thick, with angular flexures and deep channeling on the outer surface, but free from crimping. The specimen is black and heavy, and bears patches of marine incrustation.

The dimensions are:—

Extreme length, 5·2 in. Width of crown at second ridge, 2·3 in. Width of crown at seventh ridge, 2·9 in.

No note was taken of the height of the last ridge. The specimen is without fangs, and, although distinctly of *E. meridionalis*, the number of ridges to the entire crown is not

shown. This also belonged to Mr. S. Woodward, and is now in the Norwich Museum. It has all the mineral appearance of the Mundesley and Happisburgh beds.

Figs. 8 and 8 *a* represent the anterior portion of a lower right molar, comprising the remains of six well-worn ridges. It is cited to show the angular flexures that are sometimes seen when the plates are ground down low. The side view, fig. 8 *a*, exhibits the thickness of the enamel. This specimen is too mutilated to fix its serial position with confidence. It is heavy and dark from iron-impregnation, and corresponds with the fragments from Mundesley and Happisburgh.

Figs. 9 and 9 *a* represent the posterior two-thirds of the crown of a lower molar of the right side. It is inferred to be a penultimate, but without certainty, and may be the last true molar. The crown shows six well-worn discs and a posterior talon; there are no fangs; the enamel is very thick, with large rings to the digitations; the discs are somewhat angularly expanded, and separated by wide interspaces of cement. This is best shown by the side view, fig. 9 *a*. From being worn low down, the plates exhibit a greater tendency to crimping than is usual. The specimen is dark and heavy, and bears fresh patches of marine incrustation. It is one of Woodward's specimens, probably from the 'Oyster-bed' (Norwich Museum).

The dimensions are :—

Length, 5·3 in. Width of crown at second ridge, 3·2 in. Width of crown at fourth ridge, 3·1 in.

This also is a characteristic fragment of *E. meridionalis.*

Figs. 10 and 10 *a* are of a specimen in Dr. Buckland's collection from the Val d'Arno. It is noticed to demonstrate how exactly the English specimens agree with the Italian form, as may be seen by comparing figs. 8 and 9 with fig. 10.

Figs. 11 and 11 *a* represent the posterior portion of a last lower molar of the right side, including six discs of wear and the back talon. The discs are broad, the interspaces of cement the same, and the enamel-plates are very thick, with deep external vertical channelling, but without crimping. The specimen is black, heavy, and bears patches of marine incrustation, indicative of its having been procured from the 'Oyster-bed.' From Woodward's collection (Norwich Museum).

The dimensions are :—

Length, 5·6 in. Width of crown in front, 2·8 in. Width of crown behind, 3·1 in.

This is also a characteristic specimen of *E. meridionalis.*

Figs. 12 and 12 *a* represent a very notable fragment of the posterior end of a last lower molar, comprising two discs of

wear and a talon. The crown is ground down low, the interspaces of cement are very wide, and the annular discs of the digitations are so thick as to approach the character of the worn ridges of some of the Stegodons.

The dimensions are :—

Length of the fragment, 2·7 in. Width of crown, 4·2 in.

A solitary digitation is situated at the outer side of one of the valleys. It bears the appearance of a Mundesley specimen.

Of the upper molars, the figured specimens in Pl. XIV. B. are less numerous; but, during the twelve years which have elapsed since it was struck off, many specimens have been amassed in the Norfolk collections which could furnish complete illustrations of the upper series. I shall confine myself to the figured specimens.

Figs. 13 and 13 *a* represent a mutilated fragment of a very old molar in the collection of the British Museum (Old Palæontol. Cat. No. 7456), comprising the remains of ten discs of wear, ground down nearly to their common base. The central discs exhibit a certain amount of open crimping. The specimen is also remarkable for the breadth of the crown; it is understood to have been derived from the 'Oyster-bed' of Mundesley or Happisburgh.

The dimensions are :—

Length of crown, 8·2 in. Width of crown, 4·3 in.

I regard it as being of *E. meridionalis*.

Figs. 14 and 14 *a* represent the crown of a fine last upper molar, left side, of a very old animal, and in an advanced stage of wear. There are nine ridges remaining, the first five of which are ground down into transverse discs; the posterior four exhibit rings that are not confluent. There is a talon behind enveloped by cement. In front of the first remaining disc there is a broad depressed surface of ivory, indicating the position of two or three worn-out discs in front. The discs are expanded, with a slight tendency to a crescentic bend, the cornua being bent forwards. The plates of enamel are very thick, and deeply channeled exteriorly, so that there is a spurious appearance of crimping on that surface; but the edges in contact with the cores of ivory are unplaited. The specimen in its mineral condition is black and heavy. It is understood to have belonged to Woodward (Norwich Museum).

The dimensions are :—

Length of crown, 9·2 in. Width of crown at second remaining ridge, 3·6 in.

The antero-posterior convexity of the grinding-surface determines the tooth to be an upper molar. (See Pl. VIII. fig. 4.)

Figs. 15 and 15 *a* represent a very remarkable fragment of enormous width. It is worn down close to the base, the grinding-surface being somewhat convex from front to rear. The remains of seven discs of wear are visible. They are irregularly expanded, and the surrounding plates of enamel are thick and deeply channelled on the outer surface, but with only a very slight amount of crimping. The specimen is dark and heavy, and patched over with fresh marine incrustations.

The dimensions are :—

Length of the fragment, 5·4 in. Width of crown, 4·9 in.!

The same plate, XIV. B., contains a representation, fig. 16, of an entire upper molar, comprising from sixteen to seventeen ridges within an extent of 11 inches. Only three of the anterior ridges are worn, the rest being intact. I now regard it as a molar of *E.* (*Euelephas*) *antiquus*, and not of *E. meridionalis*.

Captain Alexander discovered in the Mammaliferous Crag of Easton, near Southwold, a very fine specimen, of which no figure has as yet been published, of a last upper molar, right side, of *E. meridionalis*, which I have had an opportunity of examining. The crown presented twelve principal ridges; the back talon was wanting. A small portion of the tooth was broken on one side in front, but the unfractured bend of the enamel round the opposite side proved that the crown showed nearly its entire length. The tooth resembled in every respect (making allowance for the difference of upper and lower) the specimen already described, found by Mr. Prestwich in the Crag, near Norwich. The three first ridges alone were touched by wear, the rest being intact. The ridges were broad, with wide interspaces, the enamel very thick and rugous, both from deep vertical channeling, and from close-set, transverse, wavy wrinkles of the surface. The digital processes were large and distinct. The ninth ridge presented five digitations. There were no fangs. The enamel-plates of the front ridges were nearly straight, and quite free from crimping. This tooth was at once distinguishable from the corresponding upper molar of *E. primigenius* or of *E.* (*Euelephas*) *antiquus*, by the thickness and low elevation of the ridges relatively to the width of the crown.

The dimensions were :—

Length of crown, 9·6 in. Width of crown in front, 3·6 in. Height of crown at the fourth ridge, 4·5 in. Height of crown at the penultimate ridge, 3·1 in.

The only other illustration of a molar of this species which I shall adduce is that described and figured by

Parkinson,[1] and reproduced in the 'British Fossil Mammalia,' fig. 93, p. 239. The origin of this specimen, which is now in the Museum of the College of Surgeons,[2] is not accurately known. Parkinson states that it was purchased at the sale of the 'Calonnian Museum,' by Mr. George Humphries, and that it was said to have been found in Staffordshire. It is a last upper molar of the left side, the crown presenting twelve ridges and an anterior talon. The first eight ridges are worn, the rest being enveloped by cement. The pattern of the grinding-surface is somewhat abnormal. Interposed between the second and third ridges there is a demi-ridge, composed of two flattened discs, occupying only the inner half of the interspace. The next two ridges are divided each into three flattened annular and well-separated discs. The three last of the exposed ridges have the apices of the digitations barely affected by wear, but showing thick mammillary points. Parkinson describes the tooth as differing from any other that he had seen, the peculiarities of character being the great thickness of the plates, the smoothness of the sides (inner) of the line of enamel, and the appearance of the digitated points of the plates (*i.e.* the interposed demi-ridge) in the anterior part of the tooth. He adds that the width of the plates may be taken at nearly double that of the fossil teeth in general, and he infers that this tooth indicated a fossil species of Elephant distinct from the Mammoth.

The dimensions are :—

Length of crown, 6·6 in. Width of crown at second ridge, 3·0 in. Greatest width of crown at fourth ridge, 3·5 in. Length of grinding-surface in use, 5·0 in.

It will be observed that all the peculiarities which struck Parkinson are those that are here considered characteristic of *E. meridionalis.* Professor Owen has described this specimen carefully, and, allowing that it unquestionably offers a great contrast to the usual form, nevertheless considers that it exhibits the characters of the thick-plated variety of the Mammoth simply exaggerated from the accidents of age and attrition. The objections, founded upon teeth of the Mammoth, which he has raised against *E. meridionalis,* will be considered with most advantage in the sequel, in the remarks upon *E. primigenius.* (See p. 148.)

Parkinson's molar differs only from the ordinary character of *E. meridionalis* in having the groups of digitations that form the flattened rings more apart than usual. The intercalation of a demi-ridge is not uncommon in the molars of fossil Elephants. This is the only 'thick-plated' variety

[1] Parkinson's 'Organic Remains,' vol. iii. p. 344, Pl. xx. fig. 6.
[2] Catalogue of Fossil Mammalia and Aves, p. 143, No. 599.

figured or described in the 'British Fossil Mammalia;' but Professor Owen states that he had seen a very similar molar of the Mammoth from the Norfolk freshwater deposits in the collection of Mr. Fitch, of Norwich.[1] The authority for the Staffordshire origin of Parkinson's molar being unreliable, no weight can be attributed to it as indicative of the distribution of the species over England.

b. *Cranium.*—No cranial fragment of *E. meridionalis* has hitherto been recorded from strata in England.

c. *Lower Jaw.*—A very fine lower jaw in the Irstead collection has already been mentioned (*antea*, p. 132). It consists of a right ramus, showing the whole of the body as far as the middle of the symphysis, and the contour of the posterior margin as high as the neck of the condyle; the coronoid apophysis and leafy expansion of the ala are broken off. The greater part of the diasteme is present.

The following are the principal dimensions:—

Extreme length from the posterior margin of the ascending ramus to the broken edge of the symphysis, 27.5 in. Length of alveolar border from the anterior margin of the ascending ramus to the diasteme, 9.5 in. Breadth of ascending ramus in a line with alveolar border, 12.0 in. Height of alveolar border at outer edge of ascending ramus, 5.7 in. Height of alveolar border in front near the diasteme, 7.7 in. Length of diasteme and symphysis remaining, 6.5 in. Vertical height of ascending ramus to neck of condyle, 12.25 in. Transverse diameter at bulge of ramus below the coronoid apophysis 7.2 in. Length of crown occupied by the two molars, 14.0 in. Length of grinding-surface in use, 7.5 in. Number of plates in use, 11.

The peculiarities distinctive of this specimen from the lower jaw of the Mammoth are:—1, the comparatively low elevation of the anterior end of the ramus, both absolutely and relatively to the height at the coronoid margin; in the Mammoth the jaw attains, in old specimens, as much as 10½ to 11 inches in vertical height; in the Irstead specimen it is but 7½ inches: 2, the long and gradual slope of the diasteme into the beak; in the Mammoth it descends with a pitch deviating but slightly from the vertical: 3, the long symphysis: 4, the greater length of the horizontal ramus in relation to the width of the ascending ramus: 5, the less sudden curve in the contour of the posterior angle and margin of the ramus. The Irstead specimen differs appreciably also from the lower jaw of *E.* (*Euelephas*) *antiquus* in points which will be noticed in the comparison of that species in the sequel.

The Norwich Museum contains a very fine lower jaw of *E. meridionalis*, comprising both horizontal rami, and, on the right side, part of the ascending ramus, the leaf of the ala being broken off. The diastemal ridges are perfect, and a part

[1] Catalogue of Fossil Mammalia and Aves, p. 240.

of the symphysis is present; but the beak has been made up artificially and uncouthly with plaster, and painted to simulate the natural fossil. The last true molar is present on either side, much worn, the anterior portion having been ground away. There are ten discs of wear, presenting the usual character of the species, the enamel-plates very thick and uncrimped. The tips of the posterior ridges form well-separated rings, and the digitations are seen to be massive. The diastemal ridges incline with an easy slope; the outer surface of the jaw bulges out a good deal; the height of the ramus in front, as in the Irstead specimen, does not much exceed the height behind under the coronoid process. This valuable specimen was discovered in the cliff, near Mundesley, in 1852, and presented by R. Barclay, Esq., to the Norwich Museum. It is not stated out of what stratum it came, *i.e.* whether from the 'Elephant-bed,' properly so called, or from the 'Laminated blue clay' above it. It is much to be desired that figures of these two instructive specimens should be published. Some of the dimensions of the Norwich jaw are as follows:—

Length of crown of left molar (last), 8·1 in. Width of crown at second remaining ridge, 3·0 in. Width of crown at sixth remaining ridge, 2·9 in. Length of crown occupied by six ridges, being an average of 0·77 in. to each, 4·6 in.

d. *Bones of the Trunk and Extremities.*—My remarks upon the other bones of the skeleton will be very limited, for several reasons. In the lacustrine and clay-deposits of the Norfolk coast, and upon the 'Oyster-bed' of Happisburgh and Mundesley, the bones and teeth of at least two of the fossil Elephants, namely, *E.* (*Loxodon*) *meridionalis* and *E.* (*Euelephas*) *antiquus*, occur intermixed in vast abundance. In consequence of the prevalent belief that they were all of one species, namely, the Mammoth, little attention has been paid to the discrimination of the precise beds and divisions of the section out of which they come, and whether from above or below the 'Boulder clay.' In no instance have the bones of an entire skeleton been found together, and there are no well-determined standard examples for comparison. The identification of the species to which the bones belonged can therefore at present be little more than approximative. [illegible] suffice to mention the principal pieces that have come under my observation from localities in which *E. meridionalis* prevails.

In Mr. Gunn's collection at Irstead, there is an entire left 'os innominatum' of enormous dimensions.

[The left side of the pelvis is nearly complete, and has the greater part of the sacrum attached to it in the relative natural position. The ilium is perfectly entire, from the tuberosity all along the crest back to

the sacrum. The acetabulum is complete, together with the greater part of the pubes and ischium. The pubic portion, forming the interior border of the foramen ovale, is wanting. Mr. Gunn's specimen is the left, which is shaded in the annexed figures. Fig. 1 represents the pelvis, looking into the cavity; and fig. 2, the front view when placed erect upon the pubes.

Fig. 1.

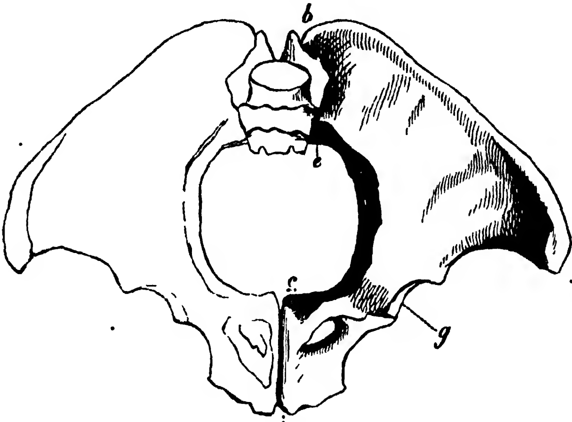
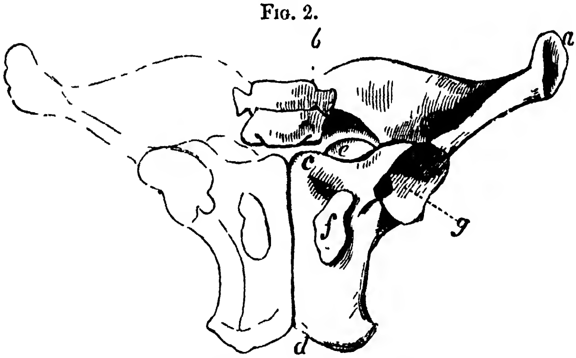


Fig. 2.



The dimensions of the specimen are as follows:—

Extreme length of ilium from the tuberosity (*a*) back to the sacral suture (*b*), measured straight with a line and not along the curve, 48·0 in. Extreme length of ilium along the curve from *a* to *b*, 63·0 in. Distance from *a* with a cord to *c*, summit of the symphysis, 34·0 in. Vertical height of symphysis pubis from *c* to *d*, 15·0 in. Width of sinus behind the acetabulum, back to sacral margin of ilium, 14·5 in. Depth from iliac crest to bottom of same sinus, 20·0 in. Distance by a cord from *c* top of pubes to *b* posterior end of ilium, 34·0 in. Distance from *c* to *e*, or posterior lower spine of ilium, 20·0 in. Girth of constriction above the acetabulum, 28·0 in. Girth of ischium at middle of foramen ovale, 12·0 in. Vertical diameter of foramen ovale (*f*), 9·0 in. Transverse diameter of foramen ovale, 6·0 in. Vertical diameter of cotyloid articulating cup, 8·5 in. Transverse diameter of cotyloid articulating cup, 9·0 in. Thickness of iliac crest, 3·0 in. From upper margin of acetabulum to summit of iliac tuberosity, 15·0 in. Length of sacrum, rump portion, 14·0 in.

In consequence of the ischial portion being broken across near the rim of the acetabulum, the exact dimensions of the cavity are not determinable, but the greatest diameter is about 9 in.

In Mr. Gunn's collection there is also the left half of another pelvis, in three fragments, of corresponding dimensions. One fragment comprises the tuberosity and a portion of the ilium; and another, the inferior portion of the ischium, broken off along the middle of the foramen ovale. The outline of the acetabulum is better defined in this specimen than in the former.][1]

In the Florentine Museum there is an enormous scapula, which has been figured by Nesti (*op. cit.* fig. 6), in the finest state of preservation; it yielded the following dimensions:—

Entire length from the coracoid process to the posterior angle, measured along the spine, 4 ft. Transverse diameter across the spine, 3 ft. Greatest diameter of articulating surface, 11 in.

The largest perfect humerus in the same collection measured:—

Length 3 ft. 11 in. Transverse diameter of inferior articulating head, 1 ft. 1 in. Girth of diameter of inferior articulating head, 2 ft. 8 in.

These dimensions are greatly surpassed by a huge humerus in the Norwich Museum, presented by Miss Anna Gurney. It is stated in the 'British Fossil Mammalia' that it was found in the 'Cliff composed of interblended blue clay and red gravel, near the village of Bacton, in Norfolk;' and the following dimensions are attributed to it:—

Entire length, 4 ft. 5 in. Circumference at the middle, 2 ft. 2 6 in. Circumference at proximal end, 3 ft. 5 in. Breadth of distal end, 1 ft. 2 in. From summit of condyloid ridge to end of the outer condyle, 1 ft. 7 in.

To what species this stupendous humerus belonged has not been exactly determined.

[In the collection of the Rev. John Gunn, at Irstead, is an enormous left humerus of *Elephas meridionalis*, obtained from the Mundesley Cliffs, near the Paston Hill, in 1861. It is even larger than that presented to the Norwich Museum by Miss Gurney. When first found it was entire, but in process of removal the distal and proximal ends were broken from the shaft, so that it now consists of three fragments. The outer surface presents a rusty colour from mineral impregnation, and is wonderfully perfect. The dimensions exceed anything to be seen in the collections of Europe, with the exception of the Val d'Arno specimens of the same species in the Museum at Florence. The characters of the species are well shown by this boue, which is short and massive as compared with the Indian elephant, or *E. primigenius*. In this respect it takes after the Tetralophodon Mastodons.

Circumference at proximal end, 5 ft. 9 in. Circumference at distal end, 3 ft. 5 in. Circumference at middle, 2 ft. 5 in.][2]

[1] The paragraphs in small type, within brackets, have been put together from entries in Dr. F.'s Note-Books, dated June 10, 1862. The figures do not represent Mr. Gunn's specimen, but were copied by Dr. F. from drawings in the 'Ossemens Fossiles' of Cuvier, to make the measurements intelligible. I am informed by Mr. Gunn that the three fragments comprising the second specimen have been put together and deposited in the Norwich Museum.—[Ed.]

[2] See note, p. 144.—[Ed.]

The largest entire femur in the collection at Florence was 4 feet 6 inches in length. The largest mentioned in the 'British Fossil Mammalia,' p. 254, attributed to a Mammoth, is stated to have been 4 feet 1 inch long.

[In Mr. Gunn's collection there is a colossal specimen of a right femur, which shows the shaft entire, but is mutilated at either end. The articular head is wanting, together with the trochanter major. It is from the forest-bed south of Bacton. Its dimensions are as follows:

Length from upper extremity where broken to lower ditto, 47 in. Girth of lower extremity where broken, 36 in. Girth of shaft in middle, 20 in. Breadth of shaft below the base of broken trochanter, 14 in.

In the Norwich Museum are two other femora of the same size, but incomplete—one from Happisburgh, the other from Miss Anna Gurney's collection. The latter is cracked and shivered like the large Norwich Museum specimen, and resembles it so much in colour and general appearance, that it may have been of same individual. Its exact origin is not known.

Girth of shaft, middle, 1 ft. 9 in.][1]

The colossal scapula of Florence is matched by a pelvis in the same collection, which was found entire in the Val d'Arno; it yielded the following dimensions:—

Expanse between tuberosities of ilium, 5 ft. 9·0 in. Height of pubes at symphysis, 1 ft. 9·5 in. Transverse diameter of pelvic arch, 1 ft. 8·5 in. Antero-posterior diameter of acetabulum, 7·5 in. Transverse diameter of acetabulum, 8·5 in.

VI. Characters of Euelephas.

1. *General Remarks.*—This group, regarded in a structural and systematic view, is the most aberrant from the ordinary Pachydermatous type of all the divisions of the Proboscidea, and it is that of which the species are the most difficult to discriminate. It is represented in the living state by the Indian Elephant, and in the fossil state by five if not six species at present known. The obvious manner in which they differ from the Loxodons is, that the crown-divisions in the molars are more numerous, elevated, and attenuated. When the numerical values of the ridges in the successive teeth are regarded as a series, it is manifest that they go on augmenting by progressive increments, constituting the basis of the technical term here applied to signify the character, namely, an *anisomerous* ridge-formula, as distinguished from the *isomerous* formula in the Mastodons, and the *hypisomerous* formula of the Stegodons and Loxodons.

We have seen that in three out of the four groups of the Proboscidea already considered, each is susceptible of being

[1] The paragraph within brackets has been put together from entries in Dr. F.'s Note-Books, made subsequently to the date at which the memoir was written. —[Ed.]

divided into two subordinate series, namely, the 'Eurycoronine,' in which the molar crowns are broad, the ridges transverse, and the valleys open; and the 'Stenocoronine,' in which the crowns are narrow, and the valleys are obstructed by outlying tubercles. These two types, under peculiar modifications, are equally present among the forms referable to *Euelephas*, and the distinctive marks upon which they are founded furnish excellent help in determining the distinctness of the species. They are in some respects nice in degree, but at the same time, like all well-founded distinctions in nature, they are very constant. In order to facilitate the determination of the ridge-formula in the fossil forms, the characters of the teeth in the existing species will first be considered. But it is necessary to give some preliminary explanations of the modifications of the dental characters in the molars of the Euelephants, and of the terms that are here used to express them.

The folded crown of the molars in the groups *Trilophodon, Tetralophodon*, and *Stegodon* is composed of three or more, regularly or irregularly transverse, wedge-shaped cores of ivory, arising from a common base, and covered by a shell of enamel, which is uniformly reflected over their apices and over the re-entering angles at their base. These divisions are called 'ridges' or 'colliculi,' and the interstices or valleys between them 'valliculæ:' though usually open in the Mastodons, the latter are in the Stegodons occupied by an enormous mass of cement, forming reversed wedges in relation to the ivory-cores. The layer of enamel thus alternates with the ivory and cement, and, being of uniform thickness throughout, it is the only portion of the crown materials to which the terms 'plate,' 'lamina,' or 'lamella' can with propriety be applied.

In the groups *Loxodon* and *Euelephas* these ridges go on increasing in number, without a corresponding augmentation of the length of the crown, so that the penultimate true molar (or last of the intermediate series), which in the Trilophodons has only three ridges, in the Indian Elephant presents five times that number, or about sixteen ridges. The law of compensation ('balancement' of the French, and 'anamorphosis' of some German authors) comes into play to make the necessary adjustments. The ridges are compressed and close-packed, with an attenuation of the constituent ivory, enamel, and cement materials; but as there is a limit to the lateral extension of the crown, from the disturbance which would be thereby involved in the general construction of the head, the ridges are attenuated and elongated vertically, either with no increase or in an undue

proportion to the increase in the width of the crowns. But these compressed ridges are still the homologues of the massive divisions seen in the crowns of the molars of the Mastodon, and, as such, it is but correct to retain the same name for them. The obvious manner in which their elongation and compression affect the aspect of the crown is embodied in the term 'coronis lamellosa,' and the difference of degree by the terms 'broad-' and 'narrow-ridged,' instead of 'thick-' and 'thin-plated' molars.

The mammillary divisions of the ridges in the Mastodons, when worn, form discs, *i.e.* a depressed surface of ivory, surrounded by a raised rim of enamel; and by the further progress of wear the separate discs become confluent into larger discs, that are either transverse or trefoil-shaped and alternate. In *Euelephas* the divisions of the compressed ridges form finger- or quill-shaped processes, which at first are ground down into distinct 'annular discs'; two or three of these then become confluent into a compound oval disc; and at length the separate oval discs run together, forming a transverse band ('ruban' of Cuvier). Although it may not be strictly logical to apply the term 'transverse discs' to these narrow bands (tæniæ semidetritæ), still they may be regarded as very flattened ellipses; and I have found it convenient to use the term in this arbitrary sense in order to maintain a uniformity of terms in designating the same object under different modifications.

The enamel-plates furnish the most important distinctions. 1st. In regard of the thickness: in *E. primigenius* they are only half as thick as in *E. meridionalis*, and thinner than in the Indian Elephant or in *E.* (*Euelephas*) *antiquus*. 2nd. Surface-characters. The inner surface, where in contact with the ivory, is usually smooth; and the edges of the plates, in the worn discs, are even, whether the plates are straight or plaited. The outer surface is rugous and uneven in two directions:—first, vertically, from parallel or divided ribs separated by anastomosing channels, which are close-set and irregular in size, and which are most marked below, disappearing upon the apices of the digitations; and secondly, transversely, from parallel, wavy, contiguous, and very frequent *rugæ* or superficial puckering. In the vertical section these communicate a ragged, feathered edge to the outer surface of the plates; while the transverse section of the ribs and channels, in the worn plates, produces a spurious appearance of crimping, which it is important to distinguish from plaiting or folding of the enamel upon itself. The undulated margins caused by these alternate ribs and channels multiply the triturating inequalities of the enamel, and they serve

also, along with the transverse puckers, to abut the cement firmly against the enamel-plates, and diminish its liability to splinter during the process of trituration. This channelling is most strongly marked in the species which have thick plates of enamel; and when the plates are denuded of cement, the ribs between the channels simulate the appearance of cords. 3rd. Flexure of the plates transversely. This is presented under two forms: first, primary flexures, where the plates are folded upon themselves by numerous minute plicatures, closely applied to each other, and communicating a continuous zigzag appearance to the worn edge of the enamel, on both sides; this is the character to which Cuvier applied the term 'festooning,' and here called 'crimping' or 'plaiting'; second, secondary flexures, caused by the outline of the ivory-cores upon which the enamel-plates are moulded, and by the confluence of the discs of the separate digitations, according to the stage of wear of the teeth.

The presence or absence of the crimping is very constant in the different species, and very significant as a distinctive mark. Of all the species, fossil and recent, it is most marked in the existing Indian Elephant,[1] in which the crowns of the molars are comparatively narrow; and ordinarily it is entirely wanting in *E. primigenius*, in which they are broad.[2] The former belongs to the Stenocoronine type of *Euelephas*, the latter to the Eurycoronine type. The effect which is brought about in the Mastodons by the crowding of the mammillæ so as to present alternate and outlying tubercles, and in the African Elephant by the mesial rhomboidal expansion, is in the Indian Elephant accomplished by the numerous small plicatures of the enamel-plates. If these were unfolded, and the plates drawn out to the extent thus gained, the molars of the Indian species would be fully as broad, if not broader than in the Mammoth. Both species, although differing so importantly in these two characters of crimping and breadth of crown, agree in one respect—that, although presenting more or less of secondary flexures, the discs of wear are of nearly uniform width across; neither of them, as a general rule, exhibits any tendency to a mesial loop or to angular expansion; whereas in *E.* (*Euelephas*) *antiquus*, which has hitherto been so generally confounded with the Mammoth, the molars present the threefold difference of narrow crowns, with crimped enamel, and a certain amount of mesial rhomboidal expansion of the discs of wear.[3] This species, in fact, represents among the *Euelephantes* what the existing African Elephant does among the Loxodons. The difference of

[1] Pl. viii. fig. 3.—[Ed.] [2] Pl. viii. fig. 4.—[Ed.] [3] Pl. ix.—[Ed.]

E. (*Euelephas*) *antiquus* from the Mammoth corresponds with that of *E.* (*Loxodon*) *Africanus* from *E.* (*Loxodon*) *meridionalis*, the former in each case being Stenocoronine, the latter Eurycoronine.

Another circumstance that requires to be considered is the manner in which the plane of detrition modifies both the pattern and the antero-posterior diameter of the worn discs at different elevations. In the Mastodons, *M.* (*Trilophodon*) *Ohioticus* for example, the crowns are rectangular, with only a slight difference of height from front to back; the ridges come successively into wear, but the plane of detrition is nearly level in the same direction, and it makes no considerable angle with the vertical plane of the ridges. In the Indian Elephant, in consequence of the large increase in the number of ridges, the form of the crown is necessarily modified greatly. The upper molars, instead of being rectangular, are of a subtriangular and rhomboidal form, very high in front, and falling off behind. The anterior ridges attain in the last upper molar a height of 8 inches. In the progress of wear, the tooth moves forward in the arc of a circle. The anterior ridges of the opposed teeth are inclined in front, and, by their triturating action against each other, they are worn away obliquely, and the front part of the crown is ground down to the base before the posterior ridges come into use. The plane of abrasion intercepts the vertical plane of the ridges at an angle of about 60°. From this circumstance it follows that, as the ivory-cores of the ridges, however compressed, are wedge-shaped bodies, the discs of wear not only necessarily become wider as they get lower, but, from the obliquity of the plane that intercepts the ridges, they expose, in old teeth that are used down to the base, a broader surface than the actual width to the ridges, measured in a straight line. From not paying due regard to the cause, observers have been led to regard what is in reality only an accident of advanced wear in such cases as indicating 'thick-plated' varieties, and as subversive of the specific distinction between the Mammoth and *E. meridionalis*.

2. *Indian Elephant.*—The leading features of the dentition of this species are so well known from the excellent descriptions and figures of Corse, followed up by Cuvier, De Blainville, and other comparative anatomists, and the materials are so abundant in European collections, that I shall confine my remarks on the present occasion chiefly to the points which affect the determination of the ridge-formula in the successive teeth. But it is necessary to enter with some detail of evidence upon this part of the subject, as the results to which I have been led differ in some important respects

from those arrived at by previous observers, in what concerns the ridge-characters of the intermediate molars.

a. *Milk Molars.*—The antepenultimate and penultimate milk molars (m.m. 2 and m.m. 3) are seen *in situ* in the upper jaw of the young cranium figured by Corse, which is now preserved in the Museum of the India House. The antepenultimate presents four ridges, and measures but 7 inches in length. This tooth is exceedingly rudimentary in form and dimensions. The penultimate is composed of eight principal ridges, with an anterior talon-ridgelet, but no posterior talon. The eighth or last ridge is as well developed as the others, showing eight distinct digital processes. The dimensions of this specimen are:—length 2·4 inches, width in front ·9 inch, width behind 1·3 inch. The alveolus of the last milk molar, separated from the penultimate by a partition, is present in this specimen, but empty.

The lower jaw of the same cranium furnishes the three milk molars in place. The antepenultimate, like the corresponding upper tooth, is composed of four ridges, and measures ·65 inch long. The penultimate has eight principal ridges, with a small posterior talon. It is longer and narrower in proportion than the upper; it measures 2·55 inches in length. Eleven germs of the ridges of the last milk molar are lying loose in the alveolus or cavity of that tooth.

A young cranium belonging to a skeleton in the Museum of King's College, London, and having the lower jaw attached, furnishes the next stage of dentition, namely, the penultimate, and last milk molars, *in situ*. The penultimate is much worn, the two front ridges being ground down to the base. The crown presents eight principal ridges, with indications of an anterior talon. The discs of wear are wide, and the enamel-border well crimped, but with no tendency to mesial expansion. The dimensions are:—length 2·7 inches, width of crown in front 1·2 inch, behind 1·5 inch.

The last or third milk molar, left side, has a crown composed of twelve principal ridges, with a talon in front and behind. The first ridge and anterior talon are alone worn, the two last ridges and talon being unconsolidated and separate. This tooth measures in length of crown 5·2 inches, by a width in front of 1·5 inch.

In the lower jaw of the same specimen the penultimate milk molar presents eight principal ridges in a length of crown of 2·6 inches. The last milk molar is partly embedded in the alveolus, and the posterior portion concealed. Of the eight emerged ridges, the four anterior are worn. The diameter of the tusk (replaced) in this cranium is 1·1 inch.

A detached cranium, in the same Museum, furnishes the

corresponding teeth in the lower jaw, but a little older, and with the crown fully emerged from the alveolus. The penultimate presents eight principal ridges, with a small talon-splent behind. The crown is well worn, and measures:—length 2·4 inches, width in front ·9 inch, width behind 1·2 inch. The last lower milk molar has a crown composed of twelve principal ridges, with a posterior talon; the four anterior ridges are worn, the rest being intact, and the whole united by cement. The crown measures in length 4·5 inches, by a width in front of 1·55 inch. The cranium in this case, although older, is of a smaller variety than that previously described.

There are several young crania in the Museum of the College of Surgeons yielding the same teeth. In one very immature specimen (A), the antepenultimate upper is composed of four ridges and a talon; and the lower, of four ridges. Of the penultimate upper and lower, each presents only seven ridges, with front and hind talons. In another (B), which is a little older, the penultimate, much worn, and the last, partly in use, are shown above and below. The penultimate upper exhibits the remains of eight ridges; the lower is worn out. The last upper milk molar of the same specimen and the last lower show twelve ridges each, with a front and back talon.

Taking the data afforded by these examples and a great many others which I have seen in different collections, the ridge-formula of the milk molars in the Indian Elephant, exclusive of talons, is ordinarily thus:—

$$\begin{array}{c}4+8+12\\4+8+12\end{array}$$

In regard to the penultimate milk molar, an exception is admitted in the case of the young cranium (A), where this tooth, both above and below, is stated to present seven ridges in addition to front and hind talons; but the hind talons in these cases may be regarded as last ridges. Cuvier adopted the numbers assigned by Corse, namely, four ridges to the tooth here designated the antepenultimate, 8 or 9 to the penultimate, and 12 or 13 to the last milk molar. But it is to be remarked that Corse made no distinction between the talons and the ridges proper. De Blainville, in the descriptive details of these teeth, assigns to them in succession, respectively, 4, 8, and 11 ridges to the upper, and 4, 9, and 11 to 12 ridges to the lower. Owen describes the first or antepenultimate as having 4 plates, the penultimate 8 or 9 plates, and the last from 11 to 13 plates. Taking the mean of the various numbers assigned, and making allowance for want of precision in some of the cases in reference to the talons,

the numbers would nearly agree with those comprised in the above formula, which shows a progression by multiples of 4.

b. *True Molars.*—The exact determination of the ridge-formula of the true molars is embarrassed by greater difficulties; but it is a question of considerable importance, more especially as regards the ciphers of the antepenultimate and penultimate, in reference to the confident discrimination of the fossil species. For if, in the living species, these teeth should prove to be subject to any great variation in the number of their ridges, the same might reasonably be expected to hold good in the nearly allied fossil forms, and a reliance on the ridge-formula as a means of distinction would not be warranted. The causes of the uncertainty are these:—When the animal is adolescent or adult, only two at the utmost can be present at one time, on one side of the jaw, out of the six molar teeth developed during life; and of these two, only one usually is in a perfect state. If the anterior molar is in use and complete, only a part of the posterior tooth is emerged and visible. If the latter is fully protruded, the greater part of the anterior tooth will have been worn away. It is thus impossible ever to trace the details of the dental succession throughout, in any one individual. Then there is a very great difference of size between different animals of the same age. The antepenultimate true molar of a large variety may be nearly as large as the penultimate of a small one. Again, there may be a different estimate of the number of ridges in the same tooth, according to the manner in which different observers regard the talons. The same last milk molar may be described by one as having a crown composed of twelve ridges with talons, and by another as having fourteen ridges without them. Further, a slight amount of difference in the stage of wear will make an upper antepenultimate present twelve distinct ridges at one time, and only eleven when worn lower down, in consequence of the confluence of the two anterior ridges, exclusive of the talon, into one common disc. Cuvier, in his remarks on the numerical determination of Corse, has expressed his belief that they are not absolute. In proof, he cites a case observed by himself, in which the two consecutive teeth of a lower jaw presented each fourteen ridges; while in the corresponding upper jaw the anterior tooth had thirteen ridges in use, and the molar in germ behind it had eighteen ridges. With all deference to the illustrious French anatomist, it may fairly be asked whether in this instance the upper and lower jaws really belonged to the same animal. In museums it is by no means uncommon to see skulls of Elephants fitted with mandibles that do not belong to them,

either imported thus from abroad, or having been subjected to some accidental misplacement afterwards. A reliable instance of the kind alleged, as a normal arrangement, has never come under my observation, after the examination of a very large number of skulls in Europe and in India. Inferring from what is ordinarily seen in the Indian Elephant, the teeth in the upper and lower jaws in question would be regarded as belonging to distinct animals of different ages.

To revert to the numerical determinations, the antepenultimate or first true molar is that regarding which there is the most uncertainty. According to Corse, it consists of about fifteen ridges. Cuvier has not specially defined the number. De Blainville attributes to the upper antepenultimate fifteen ridges; the lower he has not characterized. Owen describes the tooth, in general terms, as having the crown composed of 15 or 16 plates (ridges), with a length of from 7 to 8 inches. The result of my observation is, that although the first true molar, in the Indian Elephant, is manifestly larger in all its dimensions than the last milk molar, it ordinarily repeats the number of ridges shown by the latter. The following are illustrations in the Museum of King's College:—Besides the two young crania already mentioned, there is a third, of adolescent age, which contains the last milk molar and the first true molar above and below. The third milk molar in the upper jaw is nearly worn out; behind it the antepenultimate true molar presents a crown composed of twelve principal ridges, with a front and back talon. The six anterior ridges are worn, the rest being intact. The dimensions are:—length of crown 6·3 inches, width in front 2·1 inches, width behind 1·5 inch. In the lower jaw of the same specimen the last milk molar is worn out; the antepenultimate true molar presents a crown composed also of twelve principal ridges, with front and back talons. The ten anterior ridges are worn; the discs of wear are well crimped, and without any mesial expansion. The dimensions are:—length of crown 6·8 inches, width in front 2 inches; width behind 1·5 inch. The cranium is well marked for reference by the loss of the right tusk, the pulp-nucleus of which had been destroyed, the third alveolus being nearly filled up. It bears a record of having been presented by Mr. Hammond.

In the collection of the Royal College of Surgeons there is a young cranium, nearly of a corresponding age, in which the same teeth are present. In the upper jaw the last milk molar is worn down to a stump, having the indistinct remains of about five ridges.

The antepenultimate true molar is in the middle stage of wear. The crown presents twelve principal ridges, with front

and back talons, making in all fourteen divisions. The five anterior ridges and talon are worn, the rest being intact. The dimensions are:—length of crown 6·8 inches, width of ditto in front 2·4 inches.

In the lower jaw of the same cranium, the last milk molar is nearly worn out; the antepenultimate true molar has a crown composed of twelve principal ridges, with front and back talons, the latter of which has a small splent appended to it. The ridges may therefore be reckoned either as 12 or 13, according to the different views of observers in regard to what ought to be considered talons. The eight anterior ridges of the crown are in full wear. The length of the crown is 7·8 inches.

I have now before me two very instructive detached specimens, belonging to the collection of my coadjutor, Colonel Sir Proby Cautley, and consisting of the right upper and lower antepenultimate true molars of the same animals. They are in the most favourable state of use for observing all the characters. The upper molar has a crown composed of twelve well-defined principal ridges, with a front and back talon. The seven anterior ridges are in wear, presenting open transverse discs with the enamel-borders strongly crimped. The posterior talon consists of a narrow splent appended to the last ridge. The dimensions are:—

Length of crown, 7 in. Width of ditto at second ridge, 2·5 in. Width of ditto at eighth ridge, 2·5 in. Width of ditto at eleventh ridge, 2·2 in. Height of ditto at seventh ridge, 6·9 in.

The corresponding tooth of the lower jaw presents a crown also having twelve principal ridges, with a distinct front and back talon. The nine anterior ridges are in use, the front talon in this instance, as also in the upper tooth, being confluent with the disc of the anterior ridge; the posterior talon is a narrow splent. The discs of wear are transverse, open and free from mesial dilatation, and the enamel-plates are well crimped as in the upper molars. The dimensions are:—

Length of crown, 7·5 in. Width of ditto at second ridge, 2·1 in. Width of ditto at eighth ridge, 2·4 in. Height of ditto at ninth ridge, 5·6 in.

In these two specimens the character which most obviously distinguishes the Euelephants from the Loxodons is well manifested, namely, the great height of the crown relatively to the width. In the upper antepenultimate, the height of the seventh ridge is almost equal to the length of the crown. The dimensions of these teeth render it certain that they are not the last milk molars.

A detached right upper antepenultimate true molar, in the Museum of the College of Surgeons (No. 2802, Osteol. Catal.),

shows also twelve principal ridges, with front and back talons. The dimensions of this specimen are :—

Length of crown, 6·8 in. Greatest width of crown, 2·5 in. Greatest height of ridges, 5·5 in.

A lower jaw in the same collection (No. 2670) shows the antepenultimate in fine preservation, presenting distinctly twelve principal ridges, with talons. The dimensions are :— length 6 inches, greatest width of crown 2·1 inches. As compared with Sir Proby Cautley's specimen, it is of small size.

On the other hand, a perfect specimen of an upper antepenultimate in the same Museum (No. 2803) shows fourteen principal ridges, besides front and back talons. The dimensions are :—

Length of crown, 6·4 in. Width of ditto, 2·5 in. Height at eighth ridge, 5·5 in.

Another illustration of the same kind is furnished by the polished section of an entire upper antepenultimate, No. 2871 of the same collection. The specimen presents fourteen principal ridges, without a posterior talon. The dimensions are :—

Length of crown, 6·8 in. Height of ditto at the fifth ridge, 4·8 in.

In this case, if the two anterior ridges were worn somewhat lower down, they would present but a single disc, with an appearance of thirteen ridges to the crown. Although the last-mentioned specimens show that the number of ridges in the antepenultimate sometimes ranges as high as fourteen, the other instances indicate that the prevailing cipher is 12, or a repetition of that of the third milk molar.

The penultimate or second true molar is described by De Blainville as being composed, in the upper jaw, of seventeen ridges, and of eighteen in the lower. Owen attributes, in general terms, to the penultimate from seventeen to twenty ridges. Corse and Cuvier have not specially defined it. A vertical section of an upper antepenultimate is represented in the 'Fauna Antiqua Sivalensis,' Pl. I. fig. 2 *a*,[1] composed of seventeen ridges, with a reduced talon-splent behind, the anterior talon being confluent with the first ridge. The dimensions are :—length of crown 8·5 inches, height of crown at eighth ridge 6·2 inches. The anterior eight ridges are worn. In the skull of a Malay Elephant in the Museum of the Royal Asiatic Society the antepenultimate and the penultimate are presented *in situ*, the former well worn, the latter in germ. The penultimate in this case is composed of sixteen principal ridges, with front and back talons. The typical specimen,

[1] Reproduced in Pl. v. fig. 2, of vol. i.—[Ed.]

figured and described by De Blainville,[1] has a crown consisting of sixteen principal ridges, with talons. The skull, No. 2659 of the Osteol. Catal. Mus. College of Surgeons, presents the upper penultimate on either side perfect, although partly worn, and the empty alveoli of the germs of the last true molar behind. The crown of the penultimate is composed of sixteen principal ridges, with a front and back talon, of which the eleven anterior ridges are worn. The dimensions are :—

Length of crown, 7·5 in. Width of ditto in front, 3·0 in.

Of the penultimate lower true molar, the majority of specimens that I have examined have also presented sixteen principal ridges, with talons. A fine illustration is afforded by the left ramus of the mandible, No. 2667 of the Osteol. Catal. Mus. Coll. of Surgeons. The inner wall of bone is removed so as to expose the embedded crown and fangs. The penultimate is complete, having in front the posterior fang-alveolus of the antepenultimate, and behind the empty cavity of the unformed last molar. The crown presents distinctly sixteen principal ridges, with front and back talons, the dimensions being :—

Length of crown, 9·5 in. Width in front, 2·4 in. Greatest width, 3·0 in. Height at fifth ridge, 5·0 in.

The five anterior ridges alone are affected by wear.

This specimen is designated in the Osteological Catalogue of the collection the last true molar; but the form and dimensions prove it to be penultimate.

A detached penultimate left lower molar in the same Museum, No. 2825, presents a crown composed also of sixteen principal ridges, with front and back talons. Eleven of the ridges are worn. The dimensions are :—

Length of crown, 9·0 in. Width of ditto at seventh ridge, 3·2 in. Height of ditto at eleventh ridge, 5·5 in.

This specimen is described in the Catalogue as the last molar, but it presents all the characters of a penultimate.

No. 2824 of the same collection, a lower ramus, left side, contains the antepenultimate and penultimate *in situ*, the former well worn and reduced to the discs of the eight posterior ridges, the latter nearly in germ, the three anterior ridges alone being slightly abraded. The penultimate in this instance also presents sixteen principal ridges, with talons.

In the Ipswich Museum there is a fine specimen of a detached penultimate molar of the lower jaw, left side, presented by Mr. C. Bree, which presents sixteen ridges, besides talons, in a length of crown of 9·5 inches. Another specimen of a

[1] Ostéographie: 'Des Éléphants,' tab. 7, fig. 5 *c*.

left inferior penultimate in the Museum at Taunton has a crown composed of sixteen principal ridges, with front and back talons. The twelve anterior ridges are worn. The dimensions in this case are:—

Length of crown, 11·0 in. Width of ditto at third ridge, 2·3 in. Width of ditto at eighth ridge, 3·1 in. Height of ditto at twelfth ridge, 6·0 in.

It is not meant to be insisted that the cipher 16 absolutely and constantly determines the number of ridges in the penultimate molar, upper and lower, of the Indian Elephant. I believe that exceptional cases occur in which they range as high as twenty in the lower penultimate in very large individuals. But, taking the great majority of instances, the prevailing number is seen to be sixteen.

The last true molar, both in the upper and lower jaws, is subject to a considerable difference of size in different individuals; but it is readily distinguishable, both by the modification i[illegible]m, and by the circumstance that the ridges constantly either attain or surpass twenty in number. Where the crown is complete, and all the ridges are present, the last upper molar ordinarily presents twenty-four ridges, and the last lower about twenty-seven. The posterior ridges in the upper molar are proportionally much less elevated than in the penultimate, the crown in profile, when unworn, presenting an outline that is nearly triangular, but prolonged backwards in the last lower molar; the posterior ridges, besides being very low, have their apices incurved upon the crown, and they diverge towards their bases somewhat in a fan-shaped manner; while, in the penultimate, the ridges are of a more uniform height from front to rear, and depart but slightly from parallelism in their general disposition.

As examples may be cited the cranial specimen No. 2662, Cat. Mus. Coll. of Surgeons, which contains the last upper molar *in situ*, in fine preservation. On the left side the alveolar wall is removed, to expose the tooth, which has a crown composed of twenty-four ridges, of which only the anterior five are worn. The dimensions are:—

Length of crown, 13·5 in. Height at the sixth ridge, 7·1 in. Width of ditto in front, where greatest, 3·2 in.

Another last upper, in a more advanced stage of wear, and yielding an excellent illustration of this tooth, is presented by the specimen No. 566 of the Cat. of Foss. Mam. Mus. Coll. of Surgeons. De Blainville has given a figure (Ostéographie: 'Des Éléphants,' tab. 7. fig. 6) of a deformed last upper molar, composed of about twenty-seven ridges.

Of the last lower molar in the Indian Elephant a longitudinal section is represented, half the natural size, by fig. 2 *b* of Pl. I. of the 'Fauna Antiqua Sivalensis.' The entire length

of the crown is about 15 inches, including in all twenty-seven ridges, of which the anterior thirteen are more or less abraded. The first five or six ridges incline a little forwards, while the posterior ridges incline so much in an opposite direction that the hindermost are nearly horizontal, producing the flabelliform character that so readily distinguishes, in most instances, the last lower molar from the penultimate. De Blainville has given, in fig. 6 of Pl. IX. of his great work, a beautiful representation of a perfect specimen of the same tooth, composed of twenty-seven ridges. Another very fine example of a last lower molar is presented by the specimen No. 557 of the Cat. of Foss. Mam. Mus. Coll. of Surgeons, there described as being of the Mammoth, but which I regard as being of the existing Indian Elephant, for reasons which will appear in the sequel. The crown is composed of about twenty-seven ridges. In the formula given in the note p. 10 of the preceding part, the numbers assigned to the true molars in the Indian Elephant are, $\frac{14+18+\ \ 24}{14+18+24—27}$; and in the definition of the subgenus, the increments in the intermediate molars are expressed by $12+14+18$. The formula was framed thus to embrace the range of variation in excess which is met with in nature, and to eschew the imputation of straining facts for a numerical harmony that certainly is not absolute. But if the ridge-formula in this species is to be framed upon the prevailing ciphers exhibited in a large number of teeth, it will run so:—

Milk molars.	True molars.
$\frac{4+8+12}{4+8+12}$	$\frac{12+16+\ \ 24}{12+16+24–27}$;

thus presenting two terms of progressive increments, the one ranging from four to twelve in the milk molars, and the other from twelve to twenty-four in the true molars, the same cipher being common to the last milk molar and to the first true molar, in accordance with what is seen in the other sections of the Proboscidea. This last circumstance is that in which my observation on the succession of the molar teeth in the existing Indian Elephant differs most from the results arrived at by previous observers.

There is no good evidence of the existing Indian Elephant having as yet, anywhere in India or in Europe, been met with in the fossil state. The specimens attributed to it by Trimmer, Mantell, and others, are referable to *E.* (*Euelephas*) *antiquus*. But undoubted fossil remains, now preserved in the British Museum, have lately been found in America, which indicate either a distinct species closely allied to the Indian Elephant, and intermediate between it and the Mammoth, or merely a

well-marked variety of the former. In either view the case is one of high interest in its palæontological and systematic relations. This form is provisionally designated *E. Armeniacus* in the Synoptical Table p. 14 of the first part of this essay. The molar teeth combine the closely approximated and attenuated ridges of the Mammoth with the highly undulated enamel-folding or 'crimping' which is so characteristic of the Indian Elephant.[1]

3. *Elephas* (*Euelephas*) *primigenius*.—In a strictly methodical order, *E. antiquus* would follow next among the European fossil species for description. But it will better suit the objects of this essay first to dispose of *E. primigenius*, the Mammoth properly so called, since most of the disputed points involved in the question of distinct species or varieties only of a single form turn upon the exact determination of the characters of the Mammoth.

Whatever may have been the approximation previously made by Merk or Blumenbach towards a distinction of the Mammoth from the two living species, Cuvier was undoubtedly the first to characterize the extinct species with exactness, in his joint memoir with Geoffrey, under the name of *Elephas Mammoth*, in the year 1796.[2] In the same year he read a memoir at the first public meeting of the 'Institute,' but which was not published until 1806, in which the diagnostic marks are very pointedly expressed under the designation of *Elephas Mammonteus*: 'Maxillâ obtusiore, lamellis molarium tenuibus, rectis,' as distinguished from *Elephas Indicus*: 'Fronte plano-concava, lamellis molarium arcuatis, undatis.' Cuvier connected these dental and mandibular distinctions with others yielded by Messer Schmidt's figure of the skull of the Mammoth, and combined the whole in the extended specific definition of the extinct form, which appeared in his memoir of 1806—'L'Éléphant à crâne allongé, à front concave, à très-longues alvéoles des défenses, à mâchoire inférieure obtuse, à mâchelières plus larges, parallèles, marquées des rubans plus serrés.' He abandoned the name *E. Mammonteus* of his memoir of 1796, and adopted the designation of *Elephas primigenius*, proposed by Bluemenbach,[3] in 1803, which is that now generally accepted among palæontologists. To this normal form, as already stated, Cuvier referred all the fossil remains of Elephants found over the whole of Europe, in Northern Asia, and in North America, however much at variance with the terms of his definition; and to the last he clung to the specific unity of the 'Éléphant fossile' with the

[1] See Memoir in *Elephas Columbi*.—[Ed.]

[2] Mém. de l'Institut, 1re Classe, tom. ii.

[3] Voigt's Mag. 1803, Band v. p. 16.

jealous partiality of a discoverer for the earliest results of his most cherished labours.

The distinctive characters in the molars of the Mammoth, as compared with those of the existing Indian Elephant, upon which Cuvier relied, may be expressed in the following terms:—

1. Great narrowness or compression and approximation of the crown-ridges, involving both a larger number in the same length of crown and in triturating use at the same time.

2. Tenuity of, and absence of crimping in, the enamel-plates.

3. Greater width of the molar-crowns, both absolutely and relatively to their length.

These peculiarities, when combined, are very constant in the Mammoth. Exceptional cases have been admitted by Cuvier, and adduced by others; but, when closely examined, they have proved either to belong to other extinct species or to be disguised molars of the existing Indian Elephant.

Taking the molars of the Mammoth in succession from first to last, they yield the descriptions which follow:—

a. *Upper Milk Molars.*—Of the milk molars of the upper jaw, the antepenultimate or most anterior, from its rudimentary form, appears to have been shed at a very early period, and it is consequently but rarely observed *in situ* in the fossil state. It is inferred to have been composed of four ridges, with talons like the corresponding rudimentary tooth of the Indian Elephant.

The penultimate milk molar (or second in appearance) is much more common, especially in cave collections. I observed in the Taunton Museum no fewer than eight worn penultimates, upper and lower, in the collection formed by the Rev. D. Williams, from the Mendip caverns. There are several also in Mr. Beard's collection at Banwell, and one in the collection of the Geological Society, from Kent's Hole. The displayed part of the collection in the British Museum contains a few examples of this tooth referable to the Mammoth, and it exists also in the collection of the College of Surgeons. The crown, as in the corresponding tooth of the Indian Elephant, is composed of seven or eight ridges, with talons. A fine specimen, in the Museum at Taunton, from one of the Mendip caverns, in perfect preservation, with the fangs present and the crown worn, presents seven principal ridges, besides front and hind talons.

The dimensions are:—

Length of crown, 2·3 in. Width of crown at second ridge, 0·9 in. Greatest width behind, 1·4 in.

From the dimensions it will be seen that the crown is narrow

in front and broad behind, yielding somewhat of an ovate outline. The specimen in the collection of the Geological Society, from Kent's Hole cavern, is a penultimate upper milk molar of the right side, with the crown much worn and the anterior portion ground out. The discs of the six posterior ridges remain.

The dimensions are:—

Length, 2·2 in. Width behind, 1·3 in.

The specimen (No. 583 of the Cat. Foss. Mam.) in the Museum of the College of Surgeons is a left upper maxillary, containing the penultimate milk molar far advanced in wear. The crown in this case is also much worn, presenting the discs of six principal ridges and a hind talon. The specimen is reputed to be from the Drift-beds at Ilford.

The last milk molar, or third in succession, of the upper jaw of *E. primigenius*, abounds in English collections, both from the caverns and from the Drift-beds. It is readily distinguished from the same tooth in the other species, fossil or recent, by the broad squat form of the crown and the closely approximated ridges and uncrimped enamel-plates. A fine illustration of this tooth is presented by the Hunterian specimen (No. 585, Cat. Fossil Mam.) in the Museum of the College of Surgeons, from Hinton, Somersetshire. The crown is composed of eleven principal ridges, with talons, the anterior part being slightly worn, showing the discs of five or six ridges; the posterior ridges are intact.

The dimensions are:—

Length of crown, 3·6 in. Width in front, 1·5 in. Greatest width, 1·8 in. Height at sixth ridge, 2·6 in.

The ridges are closely approximated, and the attenuated layers of enamel free from crimping. In the descriptive Catalogue (p. 140), the crown is regarded as being composed of twelve plates, the last being here considered the posterior talon.

Another illustration of the same tooth, a right upper, may be cited in a British Museum specimen, No. 156 of the Palæontol. Cat. The crown is composed of eleven principal ridges, besides talons; the six anterior ridges are worn.

The dimensions are:—

Length of crown, 3·7 in. Width in front, 1·4 in. Greatest width, 1·9 in. Height at sixth ridge, 3·0 in.

A third illustration is afforded by a germ-specimen of a left molar from Kent's Hole cavern, in the Museum of the Geological Society. The crown is composed, besides talons, of twelve principal ridges, of which the first alone is abraded, the rest being intact.

The dimensions are :—

Length of crown, 4·6 in. Greatest width at second ridge, 1·8 in. Height at second ridge, 4·0 in.

Numerous other examples of this tooth might be cited, presenting either eleven or twelve ridges, with talons. De Blainville describes it as being composed of eleven, and Professor Owen of from twelve to fourteen ridges, the talon-plates in the latter case being probably taken into the reckoning.

b. *Lower Milk Molars.*—Of the lower milk molars, the antepenultimate, or most anterior, is exceedingly rare in collections. An illustration of it is furnished by the specimen figured and described by Kaup, under the name of *Cymatotherium antiquum.* Like the corresponding rudimentary tooth in the Indian Elephant, it is inferred to be composed ordinarily of few ridges. There is a specimen in the British Museum (No. 33,403), from Mr. Layton's collection,[1] which contains the sockets of the two anterior milk molars; but the crowns are wanting.

Of the penultimate milk molar of the lower jaw, there is a fine specimen in the Taunton Museum, from one of the Mendip caves, in perfect preservation, with the fangs present and the crown worn. It is composed of seven principal ridges, besides front and hind talons; the latter is so large that the crown may be regarded as comprising eight principal ridges without a hind talon; the grinding surface presents no inequalities in the shape of raised machærides, the cement, ivory, and enamel being on a uniform level, as if polished.

The dimensions are :—

Length of crown, 2·3 in. Width at second disc, 0·9 in. Greatest width, behind, 1·4 in.

From these dimensions it is seen that the crown is narrow in front and about half an inch wider behind, yielding somewhat of an ovate outline. Other illustrations might be cited, in which the crown of the penultimate lower milk molar presents eight ridges, besides talons.

Of the last milk molar of the lower jaw (third in the order of appearance), a very fine example *in situ* is afforded by a cast of a mandible in the Museum of the College of Surgeons. Both rami are complete, with the exception of the articular surfaces of the condyles. The last milk molar, well worn but perfect, is present on either side, with the

[1] This specimen is probably from Happisburgh, and has evidently been in the sea.

empty sockets of the penultimate in front and of the first true molar behind.

The dimensions of the last milk molar, left side, are:—

Length of crown, 3·9 in. Width in front, 1·2 in. Greatest width behind, 1·7 in.

The crown is composed of twelve ridges, with talons closely approximated. The original of this specimen is reputed to have been found in the superficial deposits of the valley of the Rhine.

Another example of the last milk molar of the lower jaw, detached, may be cited in the specimen in the collection of the British Museum, No. 21,315, from Ilford, Essex. The crown is composed of twelve principal ridges, with talons, the anterior six being worn and the rest intact; the ridges are closely approximated, and the discs of wear form parallel transverse bands, with no tendency to expansion in the middle, and with the plates of enamel attenuated and free from crimping.

The dimensions are:—

Length of crown, 3·7 in. Width of crown in front, 1·1 in. Greatest width behind, 1·5 in. Height at the seventh ridge, 2·3 in.

Numerous other examples might be cited; but these two suffice to indicate the ordinary characters of the tooth.

The third milk molars in the Mammoth, upper and lower, are distinguishable with facility from those of *E.* (*Loxod.*) *meridionalis* and from *E.* (*Eueleph.*) *antiquus* by the duodenary cipher regulating the crown-ridges, and by the tenuity of the enamel-plates; but the antepenultimate and penultimate are much less easily discriminated.

[1] [In the Woodwardian Museum at Cambridge is a superb fragment of the right ramus of the lower jaw of *E. primigenius*, containing the last milk molar *in situ*, quite perfect. The crown exhibits the normal number of twelve collines, of which four only are worn.

In the Museum at Turin, mixed up with specimens of molars from St. Paolo, I found an entire lower milk-molar of *E. primigenius*. It bears a loose label as being Piedmontese, and is probably the specimen referred to by Sir Charles Lyell as a doubtful case of an Italian *E. primigenius*. The loose label possibly belongs to another specimen; and the specimen is in exactly the same mineral condition as another specimen found in the same collection from Fœderburg (see p. 173), which differs from that of the ordinary character of the Piedmontese specimens; and as the latter is avowedly German, it is probable that the same is the case with the former. So far as the *certain* evidence goes, I have seen no proof hitherto that *E. primigenius* has been met with anywhere fossil in Italy [2]—so far, at least, as is shown by the col-

[1] The paragraphs in small type within brackets are extracted from entries made in Dr. Falconer's Note-books.—[ED.]

[2] Subsequently Dr. F. found satisfactory evidence of the existence of *E. primigenius* in Italy (see pp. 170, 173, and 241).—[ED.]

lections at Florence, Pisa, and Turin; all of which, at the first and last places, I have most carefully examined, with a view to determine the point (1859). Dimensions of the lower left third milk molar:—

Extreme length, 5·2 in. Width in front, 1·9 in. Width behind, 2·4 in. Height of crown, 3·5 in.]

Taking the numbers yielded by the examples above given, it is seen that the ridge-formula of the milk molars in *E. primigenius* is identical with that of the existing Indian Elephant, and liable to the same variation as regards the antepenultimate, upper and lower, as is met with in that species, namely, the ridges varying from seven to eight. The formula may be expressed thus:—$\frac{4+8+12}{4+8+12}$, exhibiting a progression by successive increments of four.

c. *Upper True Molars.*—The circumstances which render it difficult to determine with precision the ridge-formula of the true molars in the existing Asiatic form apply equally to those of the Mammoth; and, in consequence, the ciphers of the antepenultimate and penultimate, being the two posterior intermediate molars, have heretofore been but vaguely ascertained. Cuvier had not advanced sufficiently far in the investigation of the subject to attempt to determine them. De Blainville attributes from fifteen to sixteen ridges to the antepenultimate, and eighteen or nineteen to the penultimate, in the upper jaw. Owen considers the antepenultimate (fourth in succession) to have been subject to considerable variation in the number and proportion of the ridges, which he estimates as ranging from twelve to sixteen, the greater number being usually in the lower molar. Of the penultimate he describes the ridges as ranging even from sixteen to twenty-four. Upon the examination and comparison of a very large number of specimens, I have been led to the conviction that, ordinarily, the antepenultimate upper true molar repeats the duodenary cipher of the last milk molar, and that the penultimate, as in the Indian Elephant, advances by an increment of four ridges.

First, in regard of the antepenultimate upper, or fourth in the order of horizontal succession. A very fine illustration of this tooth *in situ* is presented by a specimen in the Museum of the College of Surgeons (No. 620, Cat. Foss. Mam. p. 153), comprising the palate with a molar on either side, and in front of it the empty fang-pits of the last milk molar which had been shed. The crown of the antepenultimate is worn to the last ridge, but quite perfect, and presents the discs of twelve principal ridges, with talons; it is very broad in relation to the length, and, when compared with the corresponding tooth of the existing Indian Elephant, it looks short

and squat; the outline is nearly a parallelogram, of which the length is less than twice the width; the discs of wear are closely approximated, forming narrow transverse bands; the enamel-plates are very thin, with a slight tendency to minute irregular undulation, nowhere amounting to crimping.

The dimensions are :—

Length of crown, 5·1 in. Width of crown in front, 2·4 in. Width of crown behind, 2·4 in. Greatest width of crown, 2·75 in.

This specimen is of North American origin.

[1] [I have also examined two specimens of the first true molar, upper jaw, of *Elephas primigenius*, in the collection of the Rev. S. W. King, from the Norfolk Coast section, near Cromer. The specimens were carefully compared with a molar from Ilford, in the valley of the Thames, belonging to Mr. Prestwich (see p. 165).

The specimen first to be noticed, marked No. 3, is labelled 'Picked out of *blue clay and black gravel* on beach, solid level, after scouring from shoot of cliff, in March 1860. (Anderson, Cromer.)'

It is a very perfect example of an antepenultimate true molar, upper jaw, right (t.m. 1), presenting the crown quite perfect. The crown is composed of twelve principal ridges, with front and back talons; the nine anterior ridges are worn, the rest intact and enveloped in cement. The most anterior ridge is confluent in its disc with the adjoining talon disc. The second disc is confluently transverse, somewhat irregularly reniform in its contour, the convexity being directed backwards. The third is composed of three semi-detached, oblong discs, the worn digitations not having become quite confluent. The four or five posterior ridges are but very slightly affected by wear. The ground surface of the crown is broad relatively to the length of the molar; the ridges are high, thin, and closely compressed. The plates of enamel are decidedly thin, presenting no appearance of crimping or primary undulation, the only plicature shown being that produced by the confluence of the discs (i.e. secondary undulations). In all these respects this molar bears a very close resemblance to Mr. Prestwich's Ilford specimen. The fangs are all broken off below, where, in the interstices, the matrix is distinctly seen, in some places penetrating into the hollow cores of the fangs. This matrix consists of a very ferruginous, fine sand, containing small pebbles, and closely agrees with the matrix of the 'Elephant-bed' at Mundesley. There are also some patches of blue clay, resembling that of the laminated blue beds. There is no appearance of a disc of pressure behind, but this is intelligible from the semi-worn condition of the tooth. The fresh broken surfaces of the ivory of the fangs presents a dull chocolate or pale sepia colour, like that of the Mammoth molars from the 'Big-bone Lick' of America: it burns black and yields a strong odour of ammonia, proving abundance of gelatine. All this is against the remote age of the fossil, and would indicate that it was yielded rather by some of the

[1] The paragraphs in small type within brackets have been compiled from entries in Dr. Falconer's Note-books, made subsequently to the date at which the memoir was written.—[Ed.]

upper gravel-beds, or blue clay below the boulder-clay, than that it came out of the 'Elephant-bed.'

The dimensions are :—

Length of crown at top, 5·5 in. Length below, above the fangs, 4·55 in. Width of crown in front, 2·4 in. Width in middle, 2·23 in. Width behind, 2·1 in. Length occupied by eight anterior discs, 2·9 in. Extreme height of crown at ninth ridge, 5·6 in.

I regard this specimen as being an antepenultimate of *Elephas primigenius*. N.B. The posterior talon is a little abraded behind.

The second specimen, labelled 'No. 2, from *blue clay and black gravel*, beach, Cromer; scoured down after shoot of cliff, under lighthouse, March 1860. (Anderson, Cromer.)'

This specimen in a general way very closely resembles No. 3, just described; like it, the crown is very perfect, and composed of twelve ridges, with front and back talons. The grinding surface has extended over the eight anterior ridges. The front ridge is confluent with that of the disc of the anterior talon, which has partly disappeared from pressure. This front disc has the enamel-plate surrounding it somewhat folded, but without crimping; the folds being secondary undulations, arising from the confluence of the digitations.

The second disc is transverse, and somewhat folded in a similar manner, but without true crimping. The third, fourth, and fifth ridges, present each three distinct and non-confluent flattened discs. The sixth and seventh show about five flattened annular rings. The rest of the ridges, back to the talon, are quite entire and enveloped in cement. There is no indication of a disc of pressure, and the talon is quite perfect.

This tooth closely resembles that above described; it is somewhat smaller, and belonged to the left side. It does not appear, however, to have belonged to the same individual. The crown-discs are somewhat wider and more open, with less appearance of compression, but not to a greater extent than is compatible with individual variation. The specimen agrees, in colour and character of the matrix impacted in the fang interstices, with No. 3. The fresh ivory fracture yields the same sepia discoloration; and when burnt it gives a strong odour of ammonia (burnt blanket), proving abundance of gelatine. I regard this specimen as also of *E. primigenius*.

The dimensions are :—

Extreme length of crown, 5·7 in. Extreme length above fangs, 4·4 in. Width of crown in front, 2·1 in. Width in middle, 2·3 in. Width behind, 2·1 in. Length occupied by eight anterior discs, 3·3 in. Extreme height of crown at eighth ridge, 5·0 in.

Although presenting the ferruginous matrix of the 'Elephant-bed,' this specimen, like the former, is inferred to have been yielded by one of the superior gravels.

Mr. Prestwich's specimen (which is labelled 'Ilford, 1861') is a well-worn penultimate true molar, upper right (t.m. 2). The crown is composed of fifteen ridges, with a posterior talon. The twelve anterior ridges are more or less affected by wear; the discs of the two front ridges are worn very low and confluent into an irregular, scooped depression. The disc of a semi-ridge is interposed at the outer half, between this common disc and the next adjoining it. The third, fourth,

fifth, sixth, and seventh discs are transverse, narrow, and somewhat undulated from secondary flexures, but with no primary undulations or crimping of the enamel. The remaining ridges, on to the twelfth, are but slightly affected by wear, while the last three are intact. The ridges are compressed and closely compacted together, with thin plates of enamel and narrow cement at intervals. The crown as a whole agrees very closely in character with the Cromer specimen, No. 3. The cement is partly abraded from the sides; the specimen is uniformly tinted of a ferruginous colour. The ivory burns black, yielding a distinct smell of ammonia, and proving the presence of gelatine. The fangs are all broken off, but the specimen yields no indication of having been rolled.

The dimensions are:—

Length of crown, 6·4 in. Width in front, 2·7 in. Width in middle, 2·5 in. Width behind, 2·4 in. Height of crown at twelfth ridge, 5·4 in. Length of space occupied by eight of the anterior discs, 3·4 in.

I regard this as a characteristic specimen of *E. primigenius*.

P.S. The crown of Mr. Prestwich's specimen is worn down low in the front near to the fang; and on looking closely at the anterior end, a smooth, highly polished, depressed surface is distinctly seen, being the remains of the disc of pressure against the molar which preceded it, proving beyond question that the tooth is entire at this end, and that the portion supported by the anterior fang is present, the fang only being broken off or absorbed. This further proves the tooth to be the penultimate, and not the last true molar.]

De Blainville remarks that the penultimate upper (or fifth in the order of succession) in the Mammoth is rare in the French collections. He was unable to include a figure of it in the rich series of representations contained in the 'Ostéographie.' In the descriptive details of the dentition (p. 189) he cites, as a fine illustration of it, a specimen from Warsaw, on the Vistula, having a crown still composed of eighteen or nineteen ridges, although the most advanced of these are worn out; and he states that the tooth was remarkable for its large size. These circumstances throw great doubt upon the numerical rank assigned to it, which is strengthened by the fact that, in the references to the plates (p. 357), De Blainville mentions that he had no illustration of the penultimate except a bad cast, and that it was therefore omitted. The Warsaw specimen is probably a last true molar. Perfect specimens of this tooth, furnishing the ridge-formula of the crown complete, are also rare, so far as my observation goes, in English collections, although mutilated specimens are as common as those of the other teeth. The illustrations which I adduce are chiefly taken from foreign specimens in the most perfect preservation. The first is a very fine molar, in the Museum of Darmstadt, which I was enabled to examine by the kind permission of Dr. Kaup. It is a detached penultimate upper

of the left side, of the Mammoth, having the crown entire and all the ridges present. It is composed distinctly of sixteen principal ridges, besides a front and a back talon. The five anterior ridges alone are affected by wear, the rest being intact and perfect. The specimen yields all the distinctive characters of a Mammoth's grinder—namely, a broad crown, very high ridges separated by narrow interstices, and attenuated plates of enamel free from crimping. The dimensions of this specimen, which was yielded by the superficial deposits of the valley of the Rhine, are:—

Length of crown, 8·0 in. Width of crown, 3·0 in. Height of the eighth ridge, 7·25 in.

From the last measurement it will be seen that the height of the ridges, in the middle of the tooth even, is nearly equal to that of the length of the crown.

Another detached penultimate upper of the left side, in the same collection, presents the crown equally perfect, and composed of from sixteen to seventeen principal ridges, with talons. It differs from the specimen just described in having a proportionately broader crown, with the ridges less elevated; the dimensions being, with a nearly equal length of crown—

Width, 3·25 in. Greatest height, 6·25 in.

In the Museum at Taunton there are two very instructive specimens from the Mendip caverns—the one being an upper penultimate of *Elephas antiquus*, formerly in the collection of the Rev. D. Williams, and reputed to have been procured from Bleadon Cave; the other, a corresponding penultimate upper of the right side of *E. primigenius*, of which the precise cave locality has not been recorded. These molars are in perfect preservation, and when put in apposition they show well by contrast the distinctive characters of the two species. That of the Mammoth has the crown composed distinctly of sixteen principal ridges, besides the front and back talons; of these the eleven anterior ridges are worn, the rest being intact; the crown is very broad relatively to the length, and the ridges are closely approximated, with narrow interstices; the discs of wear form narrow transverse bands, with attenuated unplaited enamel.

The dimensions are:—

Length of crown, 6·7 in. Width in front, 2·5 in. Width at the eighth ridge, 3·3 in. Height at the eleventh ridge, 5·7 in.

The length of the crown in this specimen is considerably less than in the first Darmstadt specimen above cited; but the difference is partly owing to the circumstance that it is in a more advanced stage of wear, involving necessarily a reduction in length.

I have seen no authentic specimen of an upper penultimate of the Mammoth presenting more than sixteen or seventeen ridges. That exceptional cases do occur, in which as many as eighteen may be seen, is not improbable; but I believe that, as holds in the existing Indian species, the prevailing and normal number is sixteen. De Blainville (Ostéographie: 'Des Éléphants,' p. 195) describes as a penultimate upper the cast of a molar in the collection of M. Duhamel de Namvilliers, of which the crown presents not more than fourteen collines; but he adds that the tooth is unusually short, and that the ridges are thick. It is, therefore, very questionable whether the rank which he has assigned to it as a penultimate is correct, even if the molar belongs to the species. Many of the specimens in the Palæontological Gallery at Paris, which M. de Blainville has referred to the Mammoth, have been identified by me as belonging to *Elephas antiquus* and to *E.* (*Loxod.*) *meridionalis*

Professor Owen has given a very beautiful representation of an upper molar of a Mammoth from the Essex Till in figs. 91 and 92 of the 'British Fossil Mammalia' (p. 237), including both crown and side aspects. It is not specially described in that work; but in the 'Odontography' he states (p. 666) that the fifth (or penultimate), ranging in length of crown from 8 to 11 inches, is composed of from sixteen to twenty-four plates; and he refers to the figures above cited as illustrations of a penultimate upper of a Mammoth showing as many as twenty-four plates. The specimen, judging from the figures, is of an old molar in an advanced stage of wear; and the posterior ridges, although of less height than is usually seen in the penultimate, are comparatively high for a last upper molar of the Mammoth, as that tooth is commonly met with; but the excessive number of the ridges is, in my view, conclusive against its being a 'fifth,' and equally so in favour of its being a last true molar deviating somewhat from the common form. De Blainville has figured in the 'Ostéographie' (Tab. VIII. fig. 6) a last upper molar of a Mammoth, from the Canal de l'Ourcq, in a more advanced stage of wear, which, allowing for this circumstance, does not differ much in form from the tooth figured in the 'British Fossil Mammalia.'[1]

The last true molar, upper, of *E. primigenius* is subject to the same variation in the number of ridges as the corresponding tooth of the existing Indian species. They range from twenty-two to twenty-six, the prevailing number being about twenty-four. These teeth differ also very remarkably

[1] Mr. Prestwich's specimen (p. 165) is another example of upper t.m. 2 of *E. primigenius*.—[Ed.]

in size in different individuals; but the largest specimens have not necessarily the greatest number of ridges, the reverse being frequently seen. The tooth in outline resembles that of the Indian Elephant, being triangular, very high in front and low behind, where the last ridges gradually fall off into an angular termination; while in the antepenultimate and penultimate they are usually sufficiently high behind to communicate somewhat of a rhomb-shaped form to the crowns in their vertical contour. Examples of this tooth are common in all great collections. A very fine illustration from the Ohio is presented by the Hunterian specimen, a right upper (No. 615, Cat. Foss. Mam. Coll. Surgeons), presented by Dr. Caspar Wister, which yields all the typical characters of the true Mammoth. The crown is broad in front, narrow behind, and composed of twenty-six ridges, of which the anterior seventeen are ground down by wear. The discs of wear form narrow transverse bands, closely compressed, with thin unplaited machærides of enamel. The dimensions are:—

Length of crown, 12·0 in. Width of crown in front, at third ridge, 3·3 in. Greatest width of crown, at eighth ridge, 4·0 in. Height of crown at seventeenth ridge, 5·3 in. Length of seventeen worn ridges at summit, 8·2 in.

Another fine example of this tooth, minus the fangs, is furnished by a specimen formerly in the collection of Dr. Mantell, and now in the Jermyn Street Museum of Practical Geology. It is a last upper molar of the right side, bearing a label of 'Sea-shore'; the crown is composed of twenty-seven divisions, including the posterior talon, a small portion at the anterior end being wanting, probably not more than the anterior talon or a single ridge. The vertical outline is triangular in a very pronounced degree, high in front, and low, terminating in an angle behind. Eighteen ridges are worn into narrow parallel transverse discs, free from median expansion, and showing very attenuated enamel-plates devoid of crimping. The posterior talon forms a narrow rudimentary splent. The specimen is heavy, and tinged of a reddish colour, like those dredged from the sea. The fresh fracture is very adherent to the tongue.

[1] [In Mr. Prestwich's collection from railway cuttings at Bedford, there is a very odd-looking specimen of the last true molar, upper jaw, right side, of a dwarf-sized *E. primigenius*. It comprises about twenty plates, of which nine are worn.

In the Woodwardian Museum at Cambridge there is a superb specimen of the last true molar, upper jaw, right side, of *E. primigenius*, of very large size, and which bears all the marks of having died in captivity, in the service of man, of the flint-knife period. The anterior

[1] The paragraphs in small type within brackets have been compiled from entries in Dr. Falconer's Note-books, made subsequently to the date at which the memoir was written.—[ED.]

part supported on the front fang is worn out, but there are about twenty-four collines, eighteen of which are more or less worn; the hind part, comprising about five ridges, is very much contorted and pushed on one side, like the specimen figured in Owen's 'British Fossil Mammalia.'[1]

In the same collection there is a fragment of an upper maxillary, containing a last true molar *in situ* of *E. primigenius*, which bears all the marks of having come out of the lochs of America, or a peat-bog in England. It is of the left side, and there is no indication of the animal having died in captivity.

The Woodwardian Museum also contains a superb specimen of the last true molar, upper jaw, left side, of the *pre-glacial* variety of *Elephas primigenius*, from the Norwich Coast. Dimensions:—

Extreme length of crown, 11·5 in. Width in front, 3·1 in. Greatest width, 4·1 in. Extreme height of crown, 7·0 in.

The summit of the crown presents about eighteen discs of wear, of which the most anterior have been ground down to a common base of ivory; the space occupied by fourteen of these ridges is 7½ inches. The enamel is slightly thick, but the plates are transverse and perfectly free from any appearance of crimping. The characters of this specimen diverge widely from the ordinary form of *E. primigenius* in the direction of the Indian Elephant, but still maintain all the distinctive marks of true *Elephas primigenius*. The matrix is indisputably of the *forest-bed* of the Norfolk Coast, showing in the fangs a greenish gritty sand, full of sulphur, derived from the iron-pyrites so prevalent in the forest-bed.

Many other specimens of the last upper molar of *E. primigenius* are preserved in the Woodwardian Museum, and have been derived from various localities, such as Chesterton, and the valley of the Danube near Ratisbon. One fragment, comprising twelve or thirteen ridges, of which six are worn, is of the true post-glacial character, and bears all the marks of a gravel-matrix.

In May 1859 I carefully examined, for the second time, the only specimen of a detached upper molar of the true *E. primigenius* in the Florence collection. It consists of the last true molar, upper jaw, right side, the posterior portion with fourteen plates, and a disc common to two or three plates in front. All the plates except the last four are worn. The specimen has the cement of a reddish or chestnut colour, part of it dislaminated. The enamel is pearly looking. The ivory of the broken fangs is discoloured, like Siberian specimens, but is fresh-looking. This specimen is undoubtedly of the Mammoth, but in mineral condition and colour it differs entirely from the femur in the same collection (see p. 144); and I suspect strongly that it is not of the Val d'Arno. There is no exact knowledge of its origin.

In the Roman Museum (Sapienza) I found a fragment, comprising the anterior half of the last upper molar, right side, of *E. primigenius*, in the state of germ. The anterior angle is slightly touched by wear, but shows no characters. It comprises about twelve plates, very straight, high, and compressed.

Extreme length of fragment, 7·2 in. Height of ditto in front, 8·6 in. Height of ditto at eleventh ridge, 8·0 in. Width at eleventh ridge, 3·8 in.

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[1] Fig. 90.—This specimen is referred to again by Dr. Falconer at p. 281.—[ED.]

This specimen adheres strongly to the tongue, and is covered with Ponte Molle volcanic gravel.

In the same collection there is a fine specimen of the posterior three-fourths of the crown of a last true molar, upper right, of *E. primigenius*, comprising the fifteen posterior plates and talon: the seven last plates are intact, but the seven anterior are worn into transverse discs with no expansion. There is very great grooving of the outer surface of enamel, but no undulation.

Extreme length, 10·2 in. Height at tenth plate, 5·8 in.

It is from Monte Mario or Ponte Molle.]

d. *Lower True Molars.*—Of the antepenultimate (fourth in order of appearance) a very characteristic example is furnished by the Hunterian specimen No. 622 (Cat. Foss. Mam. Mus. Coll. of Surgeons, p. 155), consisting of part of the right ramus of the lower jaw, with one molar *in situ*, in perfect preservation. The crown is composed of thirteen principal ridges, besides front and back talon, all more or less affected by wear. The discs form transverse narrow and closely compressed bands, surrounded by thin plates of uncrimped enamel. The outline of the summit of the crown yields a short broad parallelogram, the length being less than twice the greatest width, while in the corresponding tooth of the existing Indian species the ratio is generally about three to one. The principal dimensions are:—

Length of crown, 5·1 in. Width of crown in front, 2·1 in. Greatest width of crown, 2 6 in.

The specimen is labelled as being from the Ohio, and when applied to the maxillary fragment No. 620 in the same collection, containing the upper antepenultimate (described *antea*, p. 163), the crown-surfaces fit so exactly, and the two specimens agree so closely in size, relative progress of wear, and in general appearance, that it is highly probable that they belonged to the same individual. They both present the black surface which is so common in the Elephant and Mastodon remains from the Bone-licks of the Ohio.

Another illustration of the same tooth is seen in the young mandible (Coll. Brit. Mus.) represented in the 'Fauna Antiqua Sivalensis,' Pl. XIII. A. fig. 2, which contains the antepenultimate on both sides, well advanced in wear, but complete, and the penultimate in germ behind. The crown of the antepenultimate is composed of twelve principal ridges, with talons, all of which, except the posterior talon, are affected by wear; it is broad relatively to the length, although in a less degree than is seen in the previous specimens; the discs of wear form closely compressed transverse bands with attenuated plates of enamel. It is deserving of remark that

some of these plates differ from the ordinary type of the Mammoth in exhibiting a certain amount of irregular crimping, but in no degree approaching that seen in the Indian Elephant, the presence of this character being concurrent with a less than the ordinary width of crown.

The dimensions of the tooth are:—

Length of crown, 5·3 in. Width in front, 1·85 in. Greatest width, 2·3 in.

In a specimen in the Museum at Turin the dimensions are:—

Length of crown, 5·2 in. Width in front, 1·9 in. Greatest width, 2·4 in.

In the Museum of Taunton, so rich in remains from the Mendip caves, there is a finely preserved detached antepenultimate lower molar from 'Wookey-hole,' found along with teeth of the Siberian Rhinoceros, Cave Lion, and Hyæna. The crown, although worn to the extent of seven or eight discs, is complete, and composed of twelve ridges, with front and back talons; it is broad and squat-looking, with all the usual typical characters of the Mammoth, *i.e.* narrow transverse discs with thin unplaited enamel.

The dimensions of this specimen are:—

Length of crown, 5·1 in. Width of crown in front, 2·3 in. Height at the eighth ridge, 3·5 in.

Cuvier has given a representation[1] of a young lower jaw discovered near Cologne.[2]

[In Kaup's Museum at Darmstadt there is a fine lower jaw, left side, of *E. primigenius*, from the Rhine, containing the fourth tooth, or first true molar, entire and very characteristic, but well worn. The penultimate is seen in germ behind it. The first tooth shows twelve main ridges, with a front and back heel. It is much broader than the third milk molar:—

Length of crown, 4·65 in. Width in front, 1·75 in. Width at middle, 2·15 in. Width behind, at twelfth or last ridge, 1·75 in.

As regards the penultimate lower molar of *E. primigenius*, there is, in Miss Thomson's collection at Ilford, a specimen from left side, in the finest state of preservation, comprising sixteen ridges, of which the anterior eight are more or less worn; the rest intact. This specimen bears abundance of a very dark ferruginous matrix, but not the shelly sandy matrix which characterizes the *E. antiquus* bed of Ilford.

In Mr. Grantham's collection there are some fine detached large specimens of molars of *E. primigenius*. Among others there is a lower jaw, right side, containing the penultimate molar, with sixteen ridges, or thereabout. It is a most remarkable specimen in having a prolonged symphysial beak, such as I have never seen before.

In the Taunton Museum there is a mass of bones comprising a frag-

[1] 'Oss. Fossiles,' tom. i. pl. v. fig. 5.

[2] The remaining portion of the description of *E. primigenius*, to page 176, is compiled from extracts from Dr. F.'s Note-books (see page 76, note).—[Ed.]

ment of left lower jaw of *E. primigenius*, containing one perfect molar *in situ*:—

Length of crown, 7·2 in. Width in front, 1·9 in. Width behind, not well shown, 2·7 in.

It shows distinctly sixteen principal ridges, with front and back talons; the first six ridges worn, the rest intact. This is probably a small kind of *E. primigenius*. It is evidently that species, but the tooth is excessively small for a penultimate. Attached to the outer surface are part of a second milk molar, and third milk molar of *E. primigenius*. The specimen is vastly broader behind than in front.

In Kaup's Museum at Darmstadt there is a fine specimen of the entire lower jaw of *E. primigenius*, containing the penultimate true molars on either side entire, but well worn. The sixth tooth is seen behind it in germ. The crown of the penultimate presents sixteen ridges and talons:—

Length of crown, 6·6 in. Width in front, 2·1 in. Width at middle, 2·8 in. Width behind, 2·4 in.

The jaw is considerably larger than the jaw containing the antepenultimate true molar already referred to (p. 172).

In the Museum at Zurich I examined a fine entire molar, probably penultimate, from lower jaw, left side. It is supposed to have been obtained at Canstadt. It shows fifteen plates, very thin and compressed, with a front and back talon. Its dimensions are:—

Length of crown, 8 in. Height at thirteenth plate, 5·1 in. Width of crown at seventh plate, 2·85 in.

In the collection of the Turin Museum I found, mixed up with specimens from St. Paolo, two lower molars of true *Eleph. primigenius*, the one probably a penultimate, the other probably a third milk molar (see p. 162). On examining the former carefully, an old label was found showing that the specimen came from Germany—from 'Fæderburg,' and that it was not a Piedmontese fossil. Dimensions:—

Penultimate lower, left, extreme length, 9· in. Width in front, about 2·7 in. Width behind, 3·3 in.

It has about seventeen plates, much worn.

The Museum at Arezzo contains a detached penultimate lower molar, left side, with the crown well worn. It shows an anterior large fang, but about two plates are removed; there are twelve discs of wear and a hind talon, all worn except the talon. The enamel is thin and straight, and there is no mesial expansion. This is an undoubted typical example of *E. primigenius*, but there is no indication of its exact origin. The bone adheres strongly to the tongue.

In the Mineralogical Gallery of the Museum at Rome there is a fragment of an inferior molar, left side, comprising (in two pieces which unite) the anterior half of the crown of a true *Eleph. primigenius*. The fragment includes the ten anterior ridges and the front talon; the posterior half lost by a recent fracture. Dimensions:—

Extreme length of fragment, 5· in. Length of space occupied by ten anterior plates, 4·5 in. Width of crown at second plate, 3·1 in. Greatest width at tenth plate, 5·7 in.

This is a most decisively marked specimen of *E. primigenius*, and is either the last or the penultimate left—probably penultimate. The talon is present in front, and the ten plates are all more or less worn; the first six plates are either transverse or in two discs, the outer of which is the smaller; the eighth has three discs; the ninth, five discs. The discs are a little flexuous, but transverse, without the least tendency to expansion; the enamel is thin, and entirely free from the least tendency to crimping. The matrix is a yellowish-grey fine sand, showing distinct grains of pyroxene; the ivory is quite white, and adheres strongly to the tongue. It is from Monte Sacro, near Ponte Nomentano. Professor Ponzi has no doubt of its Roman origin.

The following notes refer to specimens of the last true molar, lower jaw, of *Elephas primigenius*:—

In the Museum of the Geological Society there is a specimen of the last true molar, lower jaw, right side, comprising about twenty-two plates, from Walton, in Essex, presented by Henry Warburton, Esq. The internal fracture is excessively fresh-looking, and the enamel does not adhere to the tongue.

Mr. Gunn's collection contains a noble specimen of *E. primigenius*, dredged up at Margate. It consists of both rami of the lower jaw, the horizontal rami perfect to the tip of the symphysis; the ascending rami are also present and nearly perfect, with a broad leaf; the condyles only are gone. The specimen is especially perfect on the right side. It contains on either side the last true molar well worn. I have hardly seen anything like it in England, so perfect. It is remarkable also in being coloured superficially with the reddish chocolate tinge that immersion in the sea gives; the anterior end is very high. It ought to be figured.

In Mr. W. H. Newsted's collection, Quarry House, Maidstone, is a very fine specimen of a lower jaw, with both rami, of *Elephas primigenius*, containing on either side the last true molars quite perfect from end to end, and in front of it the fang-pit on either side for almost 1½ inch in antero-posterior diameter of the penultimate true molar, the posterior part of which has dropped out. On the left side the hollow alveolus is filled up with fine sandy matrix. The tooth on both sides is composed of twenty-two ridge-plates, of which the sixteen anterior are more or less affected by wear. The discs are very narrow, transverse and parallel, after the usual plan of the *E. primigenius* pattern, and the enamel machærides as a general rule are straight, but here and there is an occasional loop with a little flexuosity, yet nowhere any decided crimping.

Dimensions, left side:—

Extreme length of crown, about 12·0 in. Length of summit of crown, occupied by sixteen worn ridges, 7·0 in. Greatest width in front, 3·5 in. Greatest height of plates, 5·1 in.

Giving an average of 0·54 per plate.

Memo.—The specimen has been broken in two in the line of the symphysis, but the form is complete. This specimen deserves to be figured. It is from the sandy gravel-pit near the church at Aylesford, near Maidstone.

In the Woodwardian Museum at Cambridge there is a fine specimen

of a nearly perfect last true molar of the right, lower jaw, of *Elephas primigenius* (No. 295). The enamel-plates are close, attenuated, and bearing all the characteristics of *E. primigenius*.

In Kaup's collection at Darmstadt there is a specimen of the sixth lower molar, right side, with twenty-three ridges, the length of the crown being 13 inches. In the same collection there is a very fine specimen of the entire lower jaw, from the Rhine, containing the sixth tooth, partly worn on either side, and a portion of the fifth tooth in front. The sixth tooth has nineteen ridges and talons, of which the first twelve only are worn. The length of the crown is 11 inches.

In the Museum at Rome there is a lower jaw of *Elephas primigenius*, from Ponte Molle. It is most perfect on the right side, where the coronoid process is seen, and also the edge of the diasteme and part of the spout. The right ramus contains the last molar *in situ* and in wear, but the rear portion is embedded in the alveolus, and with an empty fang-pit in front filled with gravel. On the left side the whole tooth is shown (the back part of the alveolus is broken), presenting eighteen plates, and a section through the anterior large fang; which would seem to show that the bridge portion, supported by the large fang, is worn out. On the left side the crown shows the remains of eighteen plates and a posterior talon, of which the thirteen anterior are more or less worn, while the last five are intact and enveloped by cement. The discs are transverse, with not the least mesial expansion, and only a moderate degree of undulation. The plates are more approximated than in *E. antiquus*, and the crown broader for its length.

Length of remaining portion of left molar, 10· in. Width of crown at fourth ridge, 2·8 in. Greatest width, 3·2 in.

Lastly—Plate XIII. A., fig 3, of the 'Fauna Antiqua Sivalensis,' represents the lower jaw of *Elephas primigenius*, with the last two true molars on either side (see description, vol. i. p. 439).

'After the examination of a very large quantity of materials, I believe the dentary formula in the Mammoth to be thus:—

Milk Molars.	True Molars.
$\frac{4,\ 8,\ 12}{4,\ 8,\ 12}$	$\frac{12,\ 16,\ 24}{12,\ 16,\ 24}$

The plates advance by quaternary increments in each series, bearing in mind that the first true molar, although of larger dimensions, commonly repeats the number of ridges presented by the last milk molar, and that the last true molar in all the Elephants and Mastodons is more composite than the others.'

Skull and other Bones.—In Kaup's collection at Darmstadt is a fine cranium of *E. primigenius*, with only the frontal bosses broken. The orbits and right zygomatic arch are entire; the left zygomatic arch is nearly so. The occipital fossa is enormous, as in *E. Namadicus*. There are sections of both tusks in the alveoli; and the last true molar, with twenty-one ridges, well worn, is present on either side.

In Mr. Swayne's Museum at Erith, I found the greater portion of the ulna of *E. primigenius*, which is rare in English collections.

In the collection of the Rev. John Gunn, of Irstead, there is a pelvis, probably of *E. primigenius*, which was found at Mundesley in the

Elephant-bed under the Paston Hill, close to the large os innominatum of *E. meridionalis* already referred to (p. 112). It is much smaller than the corresponding bone of *E. meridionalis*. A comparison of the two exhibits well the gigantic proportions of the latter. The right ilium of *E. primigenius*, where fractured, seems to be highly infiltrated with iron.]

4. *Elephas* (*Euelephas*) *antiquus*.[1]

[The distinctive characters of the teeth of *Elephas antiquus* may be expressed in the following terms:—

1. Narrowness of the tooth in proportion to its length and height.
2. Great height of the plates. The height is more than double the width of the crown.
3. Mesial rhomboidal expansion of the discs of wear.
4. Great crimping of the enamel-plates.

The dental formula[2] of *E. antiquus* is as follows:—

Milk Molars.	True Molars.
$\frac{3+6+10}{3+6+10}$	$\frac{10+12+16}{10+12+16}$

a. *Upper Milk Molars.*—In the British Museum (Cat. No. 21,654) there is a germ of a first milk molar, probably upper. It is a most exquisite specimen, forming an unworn shell. The crown is composed of three principal ridges, *plus* talons; front talon only on one side. The specimen is from Grays Thurrock, Essex, and was purchased from Mr. Ball:—

Length of crown, 0·9 in. Width in front, 0·5 in. Width behind, 0·72 in.

In the York Natural History Museum, among the Kirkdale Cavern remains, there is a superb specimen, with fangs, of the second milk molar, upper left, of *Eleph. antiquus*, entire at both ends, but well worn. The crown presents only six principal ridges, besides talons; disc of anterior talon partly confluent with first ridge. The first ridge has two distinct discs; the second, third, and fourth discs are very expanded and highly crimped; fifth ridge little worn—crimped; in sixth ridge, tips of the digitations are barely touched. Posterior talon immersed in cement. The crown is very broad, but this is partially a distortion, from an attempted restoration with a blue clay cement in front, where the

[1] The entire description of *Elephas antiquus* has been compiled from entries in Dr. Falconer's Note-books.—[Ed.]

[2] *Dental Formula of Proboscidea, extracted from Dr. Falconer's Note-book for August* 25, 1862:—

	Milk	True	
Dinotherium . . .	1 + 2 + 3	. . 3 + 2 + 2	= 13
Trilophodon Ohioticus .	1 + 2 + 3	. . 3 + 3 + 4	= 16
Tetralophodon Arvernensis	2 + 3 + 4	. . 4 + 4 + 5	= 22
Pentalophodon . . .	3 + 4 + 3	. . 5 + 5 + 6	= 28
Stegodon insignis . .	2 + 5 + 7	. . 7 + 8 + 10 − 11	= 40
Loxodon meridionalis .	3 + 6 + 8	. . 8 + 9 + 12	= 46
Euelephas antiquus . .	3 + 6 + 10	. . 10 + 12 + 16	= 57
„ primigenius .	4 + 8 + 12	. . 12 + 16 + 24	= 76
„ Indicus . .	4 + 8 + 12	. . 12 + 16 + 24	= 76

cement had disappeared. Crown broad and oblong; looks very like *E. primigenius* in form.

Length of crown, 2·4 in. Width of crown, at 1st ridge, 1· in. Width at 3rd ridge, 1 3 in. Width at 4th ridge (greatest), 1·45 in. Width at 5th ridge, 1·2 in. Height at 5th ridge, 1·3 in.

In the British Museum (Cat. No. 23,766) there is a specimen of the second milk molar, upper jaw, left side, certainly belonging to *E. antiquus*. The crown is composed of six ridges; five ridges are worn and much expanded; front talon broad and confluent; back talon disguised. Purchased from Mr. Ball.

Length of crown, 2·65 in. Width in front, 1·09 in. Greatest height at front, 1·25 in.

In the Taunton Museum there is a specimen of an unworn germ of a second milk molar; doubtful whether upper or lower, but believed to be upper. This tooth forms a shell; no fangs remaining; ridges all formed, but no cement; shows distinctly seven ridges, with front talon small and narrow, and hind talon a low splent of four digitations; very narrow in front, broad and egg-shaped behind; marked 'Banwell,' but believed to be from Hutton; is a small tooth. Dimensions:—

Length of crown, 1·9 in. Width at 2nd ridge, ·7 in. Greatest width of crown, 1·2 in. Height of 6th ridge, 1·3 in.

Figs. 1 and 1 *a* of Plate XIV. A. of the 'Fauna Antiqua Sivalensis' represent the second upper milk molar, right side, of *E. antiquus*, with five plates. The figure is taken from a Kent specimen in the Canterbury Museum.

Lastly, one of Scharf's plates for M'Enery's projected work on the Kent's Hole fossils represents three elephants' teeth, all second milk molars—two of them germs, the third worn, and evidently of *E. antiquus*. The characters are very distinct. One of the germs has the side rubbed, exhibiting the characteristic section of *E. (Eueleph.) antiquus*—*i.e.* wide plates; and the worn crown shows the plaited enamel-plates and wide discs of the species very clearly. It is not a little remarkable that, in the MS. index of the headings, M'Enery refers to it as being the 'Indian Elephant'! This is another illustration of how shrewdly he observed; and the notes extracted from Cuvier show that he tried to master the subject of the dentition of the Elephant; but the detailed descriptions of the portion on Elephant appear to have been lost.

No. 21,301 in the British Museum collection is a superb palate specimen of *E. antiquus*, from Grays Thurrock, purchased from Mr. Ball. It contains the third milk molar on either side, well worn. The crown is long and narrow. The crowns converge, and all the plates are more or less worn. The crown is composed distinctly of nine main ridges. The anterior talon is confluent with the first disc. The hind talon is covered by cement.

Length of right molar, 5· in. Width in front at 2nd ridge, 1·7 in. Greatest width behind, 1·9 in. Interval between teeth, front, 2· in. Interval behind at second ridge from last, top, 3· in.

In the Museum at Oxford there is also a specimen of the third left

upper milk molar of *Elephas antiquus*, showing ten principal ridges, with talons; five plates are more or less worn.

Length of crown, 5·3 in. Width in front, 2·05 in. Width behind, 1·9 in. Greatest width, 2·1 in. Height at fifth plate, 4·6 in.

This is a very beautiful and characteristic specimen.

In the Museum at Saffron Walden there is a beautiful specimen of third (upper?) milk molar, right side, of *E. antiquus*, presented by W. G. Gibson, Esq.

Length, 4·25 in. Width in front, 1·6 in. Width behind, at 7th ridge, 1·5 in.

It has ten ridges, and a heel minutely crimped; front plates very wide; a tendency to expansion in the middle; all the plates in wear, the last very little touched; out of a soft clayey material.

The Bristol Museum contains a specimen of the third upper milk molar, with ten ridges, well worn; from Durdham Down.

In the Town Hall collection at Colchester is a specimen, consisting of the two maxillaries of a young *Eleph. antiquus*, containing the third milk molar, very much worn on the right side. There is an empty cavity on the left side The right tooth behind shows seven plates, all worn, with broad discs. The matrix is very ferruginous and crag-looking. It does not adhere to the tongue, and has a dark sepia colour throughout, and is sea-polished.

It was dredged off the 'West Rocks,' Essex coast, and was presented by Mr. Bolton Smith, in 1847.

Figs. 2 and 2 *a* of Plate XIV. A. of the 'Fauna Antiqua Sivalensis' represent the third upper milk molar, right side, of *E. antiquus*. The crown has ten plates. The specimen was obtained from Southwold, and is in the Museum of the Geological Society.

Length, 5·5 in. Width, 2·3 in. Height, 2·8 in.

Figs. 3 and 3 *a* of the same plate show the same tooth, left side, also with ten plates and a heel.

Length, 6· in. Width, 2·2 in. Height, 3·5 in.

b. *Lower Milk Molars.*[1]—In the British Museum Palæontological collection there are several specimens of the second lower milk molar of *E. antiquus*.

No. 18,810 is a second lower right milk molar. The crown is composed distinctly of seven discs, including the most anterior, all worn. It is narrow and concave.

Length of crown, 2·4 in. Width in front, at 2nd disc, ·9 in. Greatest width, 1 35 in.

No. 21,655 is a larger specimen, long and narrow, less worn, with large front fang; shows distinctly seven principal ridges, *plus* talon. It is the second lower left. The seven ridges are worn, but not much.

Length of crown, 3· in. Width in front at 2nd ridge, ·9 in. Greatest width behind, 1·3 in. Height of crown at 7th ridge, 1·6 in.

No. 21,310, from Mr. Ball, Ilford, is a beautiful lower jaw, left side, with symphysis, and containing second milk molar *in situ*. The crown is narrow, and composed of seven discs, which are broad, ex-

[1] I can find no note of the first lower milk molar of *E. antiquus* among Dr. Falconer's papers.—[Ed.]

panded, and crimped; appears to be of *E. antiquus*, although the species is somewhat doubtful. The alveolus of part of third milk molar is seen behind.

Length, 2·6 in. Width in front, ·95 in. Greatest width, 1·2 in.

In the Bristol Museum there are two specimens of this tooth. One from the left side is very perfect and characteristic, and shows seven plates, with front and back talons. The four front plates are worn. The second specimen is Mr. Beard's, from Bleadon Cave. It is also from the left side, and quite entire. The crown shows seven plates, with small front and back talons. The discs are thick, and the enamel plaited. The length of the crown is 2·3 inches.

In the Oxford Museum there is an exquisitely preserved second milk molar, lower jaw, right side, showing eight discs of wear besides front and back talons. All the discs are more or less worn and dilated, but there is no mesial expansion. The enamel-plates are very much crimped, but coarsely and unequally. The fangs are present, and also a disc of pressure behind. The tooth has its perfect coat of cement, while the corresponding Bristol tooth is denuded of cement. It is very narrow in front.

Extreme length, 2·65 in. Width at second plate, ·85 in. Greatest width, 1·2 in.

This is the tooth figured by Buckland in the 'Reliquiæ Diluvianæ,' and is from Kirkdale Cave.

In Major Wood's collection, from Gower caves, there is a second milk molar, lower jaw, right side. The tooth is narrow in front; the crown has seven main ridges; the back talon has an additional splent; the five anterior ridges are worn; the crown is beautifully perfect, but there are no fangs; cement present. The specimen is believed to be from Spritsail Tor.

Length of crown, 2·25 in. Width of crown in front, 3·8 in. Greatest width behind, 1·25 in. Greatest height at 8th ridge, 1·45 in.

In the Museum at Taunton there are several specimens of this tooth (l.m.m. 2). One is of large size, and has the crown worn, with seven plates; crimped enamel, flat with the surface of the crown; fangs complete.

Length of crown, 2·3 in. Width at second plate, ·9 in. Greatest width, 1·4 in.

Two other beautiful specimens have also seven discs, but are smaller, and have the enamel-edges raised. They probably belonged to the same animal.

In the Oxford Museum there is a beautiful specimen of the third milk (or first true?) molar, lower jaw, left side; the crown quite entire, showing distinctly eleven main ridges, with front and back talons; seven ridges worn. The crown is narrow, and the enamel-plates are expanded in the middle.

Length of crown, 5·6 in. Width in front, 1·8 in. Greatest width, 2· in. Height at seventh plate, 4· in.

This specimen is from Hurley, Bolton, Oxford.

In the Bristol Museum there is a third milk molar, lower jaw, right side, from Durdham Down, showing ten plates, with front and back

talons. It is very perfect; and the loop and expansion, as in *E. antiquus*, are typical.

The collection of the Rev. John Gunn, at Irstead, contains a very characteristic third milk molar, lower jaw, left side, of *E. antiquus* (East Coast, No. 2). It shows ten plates, all more or less ground, and its dimensions are :—

Length, 4·9 in. Width in front, 1·5 in. Width behind, 2· in.

Lastly—Figs. 6 and 6 *a*, and figs. 7 and 7 *a*, of Plate XIV. A. of the 'Fauna Ant. Sivalensis,' represent two specimens of the third upper milk molar. Fig. 6 is taken from a specimen from Suffolk, presented by Dr. Cooke to the Geological Society (No. 8,411); it is from the right side, and has seven well-crimped plates, but is imperfect.

Length, 4·2 in. Width, 2·1 in. Height, 3· in.

Fig. 7 is also from the right side, and shows nine well-crimped plates and a portion of a tenth behind, where the tooth is not quite perfect. The tooth is narrow in front and broader behind. (See Plate IX. figs. 1 & 2 of this volume.)

Length, 5·4 in. Width, 2 in. Height behind, 2·5 in.

c. *Upper True Molars.*—Among Mr. Dixon's specimens in the Palæontological collection of the British Museum, No. 28,512 is a fine specimen of the first true molar, upper jaw, right side. It is entire, with fangs. The crown is composed of twelve ridges; the nine anterior ridges are worn. The tooth is excessively like one belonging to Mr. Rupert Jones, from Suffolk, but is narrower.

Length of crown, 7·7 in. Width in front, 2·2 in. Greatest width, 2·7 in. Height at 9th ridge, 5·4 in.

The corresponding tooth of opposite side has also twelve ridges.

Dimensions of Mr. Rupert Jones's specimen :—

Length of crown, 8·6 in. Width in front, 2·7 in. Greatest width, 3·2 in. Height at 9th ridge, 7·5 in.

Another specimen in the British Museum (No. 18,759) of the same tooth has ten ridges, seven of which are worn.

Length of crown, 5·9 in. Width in front, 2·1 in. Width behind, 1·8 in. Height at 7th ridge, 4·6 in.

In the Museum of the Geological Society there is a specimen of the antepenultimate true molar, upper jaw, right side, of *Euelephas antiquus*, labelled No. 8,409, as being from Southwold. It is entirely free from mineral impregnation, and I doubt its asserted Southwold origin.

In the Museum at Taunton, among the specimens collected from the caves by the late Rev. Mr. Williams, there is a very fine molar, upper jaw, right side; crown worn, but quite perfect, showing twelve principal ridges, with talons. The front talon is confluent with the anterior disc; the hind talon is unworn. The twelve ridges all worn into discs; the discs are a little expanded; machærides raised; enamel irregularly but well plaited; front fang and surface of pressure present. This tooth is convex outside and concave on the inner side; the plane of wear slopes from inside, out. It is not known which cave the specimen is from, but it is supposed to be from Bleadon, most of Mr. Williams's specimens being from Bleadon.

Length of crown, 7·2 in. Width of crown at 2nd ridge, 2·3 in. Width behind, at 8th, 2·8 in. Height of crown at 9th, 5·6 in.

Among some specimens belonging to Mr. Charlesworth, which I have been permitted to examine, there is a fine upper molar, right side, of *E. antiquus*, showing twelve ridges, of which nine are worn. The discs of wear are less open and expanded than usual, but the enamel is thick and crimped, of the *E. antiquus* pattern. The crown is narrow. The specimen is reputed to be from Happisburgh; but it has no Lepralia patches. (See *antea*, page 134, note.)

In the Museum at Chichester there is a beautiful specimen of first true molar of left upper jaw, quite entire, showing twelve plates in all, nine of which are worn. All the fangs are present. The enamel and plates are most characteristic. From Brackelsham Bay, near Selsea.

In the Museum at Rome there is a fine specimen of *E. antiquus*, from Monte Verde. It is a skull of a youngish animal, which was found nearly perfect, but is now partly mutilated. It contains on either side three plates of the last milk molar, worn out; the first true molar in full use, and the second true molar behind—four plates of it being shown.

The first true molar is beautifully shown, the crown consisting on left side of ten principal ridges, with front and back talons; all the plates well expanded and crimped; nine of the plates more or less worn. The palate is filled with a sandy conglomerate, with some black grains of Pyroxene (volcanic).

Length of first true molar, 5·5 in. Width of first true molar in front, 1·7 in. Greatest width behind, 1·9 in. Interval between molars in front, 2·4 in. Interval behind, 3·1 in. Interval in front, outside, 5·5 in. Interval outside, behind, 6· in.

An imperfect specimen, from Southwold, of the first upper true molar, right side, is figured in the 'Fauna Antiqua Sivalensis,' Plate XIV. A. figs. 4 and 4 *a*. The crown has nine plates, and the dimensions are:—

Length, 5·5 in. Width, 2·6 in. Extreme height, 6·5 in.

In the Museum of the Geological Society (No. 10,664) there is a second or penultimate upper molar, right side, of *E. antiquus*, well advanced in wear; the anterior part is broken off; the nine posterior ridges are present, all more or less worn with the exception of the last. This specimen is of a dark iron-shot colour, and highly infiltrated with ferruginous matter; it is extremely heavy, and bears all the marks of a crag specimen; locality, 'Southwold.' The enamel is thick, and the worn discs exhibit the characters of the species in the most pronounced manner. If the asserted locality be correct, this is the only known species of Elephant molar found in the Red Crag. Specimens of *E. meridionalis* have been found in the Norwich crag by Mr. Prestwich; and by Mr. Gunn, in the same crag where Mr. Layton found the Mastodon teeth, a molar of *E. antiquus* was found. It is of the utmost importance to determine accurately the origin of this specimen.

In Colonel Wood's collection from Minchin Hole there is a superbly characteristic specimen of the penultimate upper right molar of *E. antiquus*, showing fourteen plates and a posterior talon. The six anterior plates are worn; the worn part might almost pass for the existing Indian Elephant; the tooth narrows very much backwards; the crown is perfectly entire; the lateral mass of cement is enormously thick; the discs not much expanded, but beautifully crimped.

Extreme length of crown, 8·4 in. Width in front, 3· in. Height at 6th plate, 6·6 in.

In the Woodwardian Museum at Cambridge there is a fine specimen of the last upper molar, left side, of *E. antiquus*. It is quite perfect, consisting of sixteen ridges, of which the anterior eleven are more or less worn. The discs of wear are expanded and opened, with thick boldly crimped enamel, and exhibit all the characteristic marks of the species in the most typical way. The specimen is probably the most perfect remain of a last true molar of the species in the kingdom, but unluckily the locality has not been recorded. (Dimensions not taken.)

In the Rev. Mr. Gunn's collection there is a fine upper jaw of *E. antiquus*, containing the last true molar *in situ*, complete on both sides, and on the right side the pits of a narrow penultimate. There are sixteen plates which are high, and the tooth has all the characters of *E. antiquus*, and ought to be figured. The teeth converge in front. It was dug out of the beach from the Elephant-bed near Ostend.

Extreme length of molar, 9· in.

In the Museum of the Junior United Service Club a very fine and characteristic specimen is preserved in a glass case of the last upper molar of *E. antiquus*. The eleven anterior plates are worn; the posterior plates are unworn. The cement is cracked, but not crumbled as if out of sand.

In the Marticelli collection in the University Museum at Naples there is a magnificent specimen from Fregellæ, between Rome and Naples. It is a superior molar, bearing label, '*Molare Elefantino trovato presso l'antica città di Fregellæ.*' It is the last upper left molar, the thirteen anterior plates remaining. Disc of pressure in front and bourrelet. The four or five anterior plates are worn; enamel thin and well-crimped. Part of the tooth wanting behind; is certainly of *Eleph. antiquus*; fangs wanting.

Length of crown, 8·3 in. Height of 8th plate, 10·4 in. Width of 4th plate, 3·7 in.

The Elephant's tooth above described is of enormous size; and, in the great height of the plates of the molar, surpasses anything that I have seen elsewhere of *Elephas antiquus*. Specimens of the same tooth, but fragmentary, I have also found in the University Museums of Syracuse and Rome.

Figs. 5 and 5 *a* of Plate XIV. A. of the 'Fauna Antiqua Sivalensis' represent the last true molar, upper jaw, right side, with fourteen plates and a hind talon well-crimped. The tooth, which is rather imperfect in front, is from the Forest-bed, Norfolk, and is in the British Museum (No. 16,229). Figs. 5 and 5 *a* of Plate XII. D. show the same tooth, with sixteen ridges and a small heel much worn. The specimen is from Kent, and is in the Canterbury Museum, bearing the label $\frac{8}{2}$. Plate XIV. B. fig. 16, gives another illustration of the same tooth, and has already been referred to (see page 138, and vol. i. page 447). The crown is entire, and comprises from sixteen to seventeen ridges within an extent of 11 inches.

d. *Lower True Molars.*—In the British Museum Palæontological collection there is a specimen, which formerly belonged to the Earl of Aylesbury, of a fragment of the lower jaw of *Elephas antiquus*, containing

the first true molar on either side; the crown is entire, and presents twelve plates and a heel. The plates are worn and well crimped.

Length of right molar, 6·7 in. Width, 2·3 in.

The same tooth is shown in Plate XIV. A. figs. 8 and 8 *a*, of the 'Fauna Antiqua Sivalensis.' The crown in this specimen has also twelve plates.

Length of tooth, 8·3 in. Width, 2·5 in. Height, 4·2 in.

In the Museum of the Geological Society there is a portion of an antepenultimate true molar, lower jaw, right side, comprising six ridges; said to be from Suffolk.

In the Woodwardian Museum at Cambridge there is a fragment of right ramus of lower jaw of *Elephas antiquus*, comprising the symphysial beak, the right diasteme, and a part of the antepenultimate true molar *in situ*. Six ridges of the tooth remain, showing the distinctive marks of the species in the most perfect way. The specimen is black, polished and covered with *Balani*, showing that it has been dredged up and probably derived from the Happisburgh oyster-bank. The diastemal ridge in this case inclines very gradually forwards, contrasting in this respect in a very marked way with the character shown in the Mammoth.

Among the specimens found in Bacon's Hole, Gower, there is a beautiful and characteristic specimen of a right lower antepenultimate true molar of *E. antiquus*, with eleven plates, all worn.

In the Museum of Practical Geology, Jermyn Street, there is a quite perfect specimen of the antepenultimate, or first true molar of *E. antiquus*, from a cutting in the Great Northern Railway. It has twelve plates and a heel.

Lastly, Professor Ponzi's collection at Rome contains a beautiful first true molar, lower jaw, right side, of *E. antiquus*. It is quite entire, and *in situ* in the jaw. It shows distinctly all the ridges of the crown worn. There are ten expanded plates, with talons.

Length of crown, 5·7 in. Width in front, 1·5 in. Width behind, 1·9 in.

It is from Tor di Quinto, a continuation of Ponte Molle.

One of the most remarkable molars of *E. antiquus* I have seen was dredged up at the West Rocks, Harwich, in 1852. It belongs to the lower jaw, right side, and is probably the penultimate true molar. It comprises twelve principal ridges, with a front and back talon. Only eight of the anterior ridges are touched by wear.

Extreme length of crown, 10·8 in. Width of crown in front at second ridge, 2·9 in. Width of crown at eighth ridge, 2·8 in. Width of crown at eleventh ridge, 2·8 in. Extreme height of crown at seventh ridge, 6·6 in. Height of crown at eleventh ridge, 5·9 in. Height of crown at third ridge, between first and second fangs, 5·3 in.

In the Ipswich Museum there is a very fine specimen of a lower jaw molar, probably the left penultimate of *Elephas antiquus*, showing twelve plates, and a very insignificant talon of two points behind, the anterior part of the tooth broken off: no fangs, but a good deal water-worn below; six of the anterior plates worn, five plates unworn. The specimen is reddish, and has all the appearance of a Crag specimen. Crown very narrow; plates expanded in the middle; enamel thick, but not like *E. meridionalis* in either respect. Dredged up off

Harwich, and presented by Hedworthe Jolliffe, Esq., 4th Dragoons. Dimensions:—

Length, 8·5 in. Greatest width of anterior plate, 2·5 in. Width of 5th plate, 2·3 in. Greatest height, 5· in. Basal length of 10 plates, 7·3 in.

In Colonel Wood's collection of bones from Minchin Hole there is an extremely characteristic specimen of the second true lower molar, right side, of *E. antiquus*. The crown presents sixteen plates in all, with talons. The nine anterior plates are worn. The plates show beautifully the mesial expansion.

Length of crown, 10·1 in. Width in front, 2·6 in. Width in front at 10th ridge, 2·55 in. Width behind, 2· in. Height at 9th, 5·2 in.

In the Museum at Chichester there is a penultimate lower molar, right side, the crown of which shows fifteen plates, somewhat rolled. It is from Brackelsham Bay.

In Professor Ponzi's collection at Rome there is a magnificent lower jaw of *E. antiquus*, from Monte Verde (quaternary). Both rami are present, but they are separate, and the fragments do not fit, owing to a portion of the symphysis being wanting. The specimen is beautifully marked. The right fragment is most perfect, comprising part of the diastemal ridge, the whole of the horizontal ramus and part of the ascending ramus, as far up nearly as the base of the condyle; the coronoid plate is broken off. It contains the penultimate true molar in full use, and eight plates of the last molar in germ. It is of enormous size.

Length of diastemal portion, 5·2 in. Height of jaw at commencement of ditto, 9·4 in. Height of jaw behind, 6· in. Length of penultimate to anterior fang, 10· in. Length of penultimate, crown portion, 9·1 in. Width of penultimate in front, 2·2 in. Width behind, 3·1 in. Number of plates, 12, and talon. Greatest width of jaw behind, 7·5 in.

The penultimate has all the plates and the posterior talon worn. It shows the characters of the species beautifully, with a distinct mesial expansion on either side of each disc, and thick plaited enamel in good relief. The tooth is very high and compressed in front, low behind.

Figs. 10 and 10 *a* of Plate XIV. A. of the 'Fauna Antiqua Sivalensis' represent the second true molar, lower jaw, right side, of *Elephas antiquus*. There are twelve plates and a heel. The five anterior plates only are worn. The specimen is in the British Museum (No. 19,844). The dimensions are:—

Length, 10· in. Width, 2·5 in. Height, 6· in.

Three specimens of the last lower molar of *E. antiquus* are figured in Plate XIV. A. of the 'Fauna Antiqua Sivalensis.'

Figs 11 and 11 *a* show a tooth from left side, with fifteen to sixteen plates, but a portion in front is gone. The specimen is from Saffron Walden (see vol. i. p. 443). The dimensions are:—

Length, 12·3 in. Width, 3· in. Height, 5· in.

This illustration is reproduced in Plate IX., figs. 3 & 4, of this volume.

Figs. 12 and 12 *a* show the last molar from the right side. Only the eleven posterior plates are present. They are very crimped and bent. The specimen is from Happisburgh, and is now in the British Museum. The dimensions are:—

Length, 10·5 in. Width, 3·4 in. Height, 5·7 in.

Fig 1

Fig 2

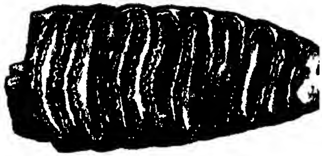


Fig 3

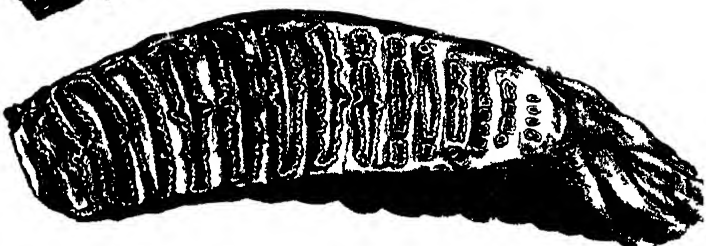


Fig 4

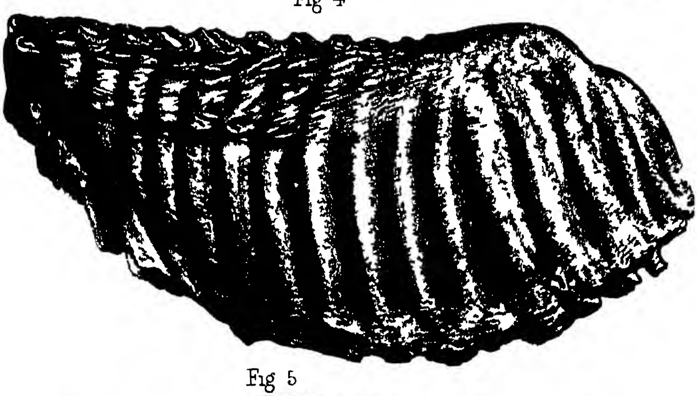


Fig 5

G H Ford del J Dinkel lith

Elephas (Euelephas) antiquus

W West imp

Figs. 13 and 13 *a* show a last lower molar, left side. There are fourteen plates remaining, but some in front are missing. This specimen is from the Via Appia, Rome. It was formerly in the collection of Cardinal Gualteri, and is now in the British Museum. (Plate IX. fig. 5.)

A more perfect specimen is represented in Plate XIII. A. fig. 4, of the 'Fauna Ant. Siv.' This drawing is taken from a very perfect lower jaw in the Museum of the Geological Society, which contains a portion of the penultimate and the last true molar on either side. The last molar is composed of seventeen ridges; the talon portion alone is wanting. The nine anterior ridges are worn, the rest are intact. The tooth is remarkably curved, being concave on its outer surface. The specimen corresponds closely in character with a specimen from Ilford, in the Museum of the Royal College of Surgeons. The origin of the specimen is unfortunately unknown.

In the Museum at Saffron Walden there is a superb specimen of the right side of a lower jaw of a fossil Elephant, probably *E. antiquus.* It contains the last molar nearly entire, with eighteen plates, all worn except the three last. The tooth contracts behind, and is concave on the outer side. The plane of wear is also concave. The plates present a loop in the centre, with bold crimping, which diminishes towards the sides. Some of the plates behind are probably wanting. The last plate in height measures 4·7 inches; the eighth, 5·4 inches.

In April 1859, I examined, in the Museo dell' Universita della Sapienza at Rome, a superb specimen of the right and left rami, detached, of the lower jaw of a fossil Elephant discovered in the quaternary volcanic sands of Magliana, on the railway cutting to Civita Vecchia. The fragments do not unite, the spout of the symphysis being wanting. The original fractured surface, covered with matrix, is seen on the left side; on the right, part of the symphysial portion remains, but a portion is seen below to have been broken off by a recent fracture. Both branches comprise nearly the entire length of the horizontal ramus and the greater extent of the ascending ramus, along the posterior contour up to the neck of the condyle. The right side is the more perfect, including a considerable portion of the diastemal ridge in front of the molar, the whole of the ascending ramus up to the neck of the condyle, and a considerable part of the coronoid apophysis, near the base, the upper part of the lamina only being broken off. The two rami are exactly alike in mineral condition, being impregnated with a ferruginous or rusty impregnation like many of the Sewalik specimens. The matrix, of which but a sparing quantity remains, is a yellowish-grey fine sand, with specks of pyroxene, red, with all the characters of the volcanic sand-deposits of the Valley of the Tiber.

Each ramus contains one molar *in situ*, in the most beautiful state of preservation, the crown surface well worn, and a thick layer of glossy cement, with its surface as uninjured as in the living state. The expansion of the discs and the flexures and undulation of the thick enamel are shown in the most perfect manner, the cement being tinged of a glossy-pale, rusty, or almond tint.

Only one tooth is present on either side, and so exactly alike in size, form, and wear, that no doubt can be entertained of their belonging to the same animal. The molar (right side) presents eleven collines and

a posterior talon. The whole of the crown appears to be emerged, but the posterior extremity behind the talon is but very slightly concealed by matrix. The discs of the nine anterior ridges are transverse; of the two last and talon, the tips are only worn. The crown is comparatively narrow in front (2·5 inches), but broader in the middle (3·3 inches). The discs of wear in front are very broad, with angular expansion in the middle resembling the African Elephant. The anterior plate of enamel in the discs is somewhat concave, in the general direction, as in the Grays Thurrock, *E. priscus*, and convex behind, with the angular expansion most distinctly pronounced there, indicating the six anterior discs.

The angle at either side projects into a loop. The expansion of the anterior discs is so great that the aggregate length of four amounts to 4 inches, or 1 inch to each, as in the African Elephant. The lateral horns of the discs are bent forwards, as in the Grays Thurrock form of *E. priscus*. The enamel of the plates is very thick, and strongly undulated. The digitations of the last emerged ridge make four ring-discs and the talon plate three; the digitations are few in number and very thick.

The jaw is high in front, at the commencement of diasteme, in relation to the height behind; and the diasteme descends very vertically, as in the African Elephant.

This is one of the finest specimens of a fossil elephant lower jaw that I have ever seen; but I am greatly perplexed to determine with confidence what it is. The tooth on the right side appears to be perfect, as also on the left, and there is no indication of a tooth coming behind. It does not seem as if any portion supported on the large anterior fang had dropped off; it is a little high there, but I failed to make out the disc of pressure. There is no appearance of another molar coming behind. In this view it would be regarded as the last true molar of *E. priscus*, but then the discs are like an exaggerated form of *E. antiquus*, and the number of the plates would correspond with the penultimate lower of that species.

On the left side the tooth has eleven ridges, talon, &c., and exhibits very considerable torsion of the plane of view. It slopes from inside out in front, and then is twisted so as to slope from outside inwards. In front a part of the tooth appears to have fallen off, as exhibited by the contour in front, about 1 inch in advance of anterior disc. Upon the diastemal ridge, near commencement, there is distinctly seen the remains of another fang. It is very difficult to say whether the crown extended as far as the fang, or whether the fang belonged to a fallen-out tooth; in the former case these plates must have fallen off, making × 16 ×.

Extreme length of crown, left, 11·4 in.; right, 12 in. Width of 1st disc outside enamel, left, 2·4 in. Width of 2nd disc outside enamel, left, 2·7 in. Width of 2nd disc with cement, left, 2·9 in. Width of 5th disc outside enamel, left, 2·9 in. Width of crown at 5th disc, with cement, left, 3·35 in. Length of 4 first discs outside expansion, left, 4· in. Length of space occupied by the 10 anterior discs in middle of crown, left, 9· in. Length of jaw from post. border of ascending ramus to anterior edge of molar, 21· in. Height of jaw in front to edge of jaw, 8·6 in. Greatest transverse diameter near coronoid, 6 6 in.

7th May, 1859.—The final result at which I have arrived is, that the tooth is the last of *E. antiquus*, and that a portion is gone in front, which was supported on the large fang.

On examining the Museum at Turin in July 1856, I was at once struck with the fact that the *greater portion* of the Piedmontese elephants' teeth were evidently not of the same species as those of the Val d'Arno, and on comparing them minutely with the figures in the 'Fauna Antiqua Sivalensis' (especially Plate XII. D. and Plate XIV. A.), I had no doubt that they were of the Chartres and Grays (in Essex) species, viz. *E. antiquus*.

There is a specimen of a huge upper last molar, right side, the extreme length of which is 13·75 in. to 14 in., and the greatest width of the crown 4·5 in. This molar is not quite complete at the anterior end; the large fang and probably the anterior talon, with one or two ridges, are broken off; but what remains shows twenty-four plates of enormous depth (8 inches!). The crown is very broad in front and narrow behind. The first twelve plates are worn; the enamel is thin, and very much crimped, especially in the middle, where there is a tendency to loop expansion. The enamel is not nearly so thick as in *E. meridionalis.* In every respect it closely resembles fig. 5 of Plate XII. D. of the 'Fauna Ant. Siv.' The apices of the digitations of the ridges, just beginning to come into wear, are very round and distinct. This specimen comes from a railway digging at St. Paolo or Nizza della Paglia. It is soft and white, and adheres strongly to the tongue.

There are also four very fine specimens, consisting of the two last upper and two last lower molars, also from St. Paolo; but unfortunately none of the teeth are entire, so that we are deprived of exact numerical information as to the crown-ridges. But they all present the marked characters of the species—viz. approximated plates of enamel, very much crimped, the plates enormously high—*i.e.* the height more than double the width of the crown. The lower jaw specimens also are very much curved outwards, and with a contorted curve to the coronal surface. All these four teeth probably belonged to the same animal—an adult. Each of the upper teeth consists of nineteen plates, the rear part being broken off.

Length of fragment, 10· in. Greatest width of crown, 3·5 in. Greatest height of plates, 7·5 in.

Of the lower molars, the right shows twenty plates, and is very narrow for its height.

Length of fragment, 12· in. Greatest width of crown, 3· in. Greatest height, 6·5 in.

Another specimen is the right side of the lower jaw, containing an entire antepenultimate true molar, with eleven ridges and a talon. The tooth is very narrow for its height and length.

Length, 7·5 in. Width of crown at third plate, 2·4 in.[1]

c. *Bones of Skeleton and Lower Jaw.*—In the Museum at Rome there are a number of the bones of the skeleton (the Pignano skeleton), evidently belonging, from the characters of the teeth, to *Elephas antiquus.* The skeleton consists of the skull and lower jaw, the vertebræ and ribs, the femur, tibia, and bones of the feet.

The Chichester Museum also contains many of the bones of the skeleton of *Elephas antiquus*, and among others a scapula 3 feet and

[1] The San Paolo molars were afterwards referred by Dr. Falconer to *E. Armeniacus.* See memoir on *E. Columbi*, page 250, and also page 192.—[Ed.]

3 inches long, eight vertebræ, one humerus, tibias, fibulas, &c.; also a tusk 8 feet long and 23 inches in circumference. These specimens were obtained from Brackelsham Bay.

In the Museum at Syracuse there is a tusk of *Elephas antiquus*, 7 feet long, and rounded in section. It was found 100 mètres above the mouth of the Amasses (?).

In the Norwich Museum there is a superb lower jaw specimen of *E. antiquus*, with the anterior portion of both sides entire, and a tooth on each side. It was obtained from the jetty at Cromer, 15 feet below ground, and was presented by W. H. Windham, Esq.

Height of jaw in front to alveolar margin, 11·5 inches. Ditto behind, at rise of coronoid, 8· inches. Height of symphysial aperture, 6·5 inches. Width of ditto, above, 3· inches, expanding below to 3·4 inches.

It is truncated off very vertically in front, with the beak directed down, but broken off. It has a thick rugous rim below the symphysial aperture. Very large foramina, about one-third below the alveolus.

·The anterior part of the tooth is worn off, the fang remaining. Including fang-portion, the extreme length of tooth of right side is about 11 inches; width in front, 3·5 inches. Contracts a little backwards; shows thirteen or fourteen plates remaining, some three or four worn off. The plates very much undulated, as in Mr. Folger's specimen, and no loop in the middle; the discs of uniform width across, but a little flexuous towards the horns; very concave in plane of wear, and the great wear on the inside. The teeth exhale a strong animal odour in burning.][1]

VII. Geological Age of Fossil Elephants.[2]

In the preceding details I have dwelt at great length on the characters presented by the molar teeth in the fossil Elephants, in comparison with those of the cranium or of the rest of the skeleton. In the fossil mammalia generally, the characters yielded by the skulls are of the highest importance in defining the genera and species; and so they would be among the Proboscidea, if attainable. But while geologists, everywhere in the gravels and fluviatile or lacustrine beds of the newer Tertiaries, meet with the fossil grinders of Elephants, crania presenting determinable characters are exceedingly rare. This arises from the very incompact and cancellar structure of the great mass of the skull in these animals, whence it arises that while the bones of the head rapidly disintegrate and crumble to pieces, the hard and solid grinders are preserved. Although many thousands of Mammoth grinders, derived from numberless individuals, have been discovered over the broad area of Europe, in the superficial deposits, I know only a single instance of a well-preserved cranium of this species (*Euelephas primigenius*) occurring in any of the great European Museums out of Russia, namely, at Mannheim, on the Rhine. Another cranium, but con-

[1] See page 176, note 1.—[Ed.]   [2] See page 76, note 1.—[Ed.]

siderably less perfect, has been acquired, by the indefatigable energy of Dr. Kaup, for the Museum at Darmstadt. It is of importance to geologists to have pointed out to them the characters of the remains that are most frequently encountered, and which are of the readiest application and of most significance in the distinction of the species. Hence the undue proportion in which I have directed attention to the dental character of the fossil Elephants in the present communication.

I shall now proceed to the consideration of the bearing of these fossil Elephants, regarded as distinct species, upon the classification of the newer tertiary strata.

There is probably no locality in Europe so favourably situated for the investigation of the mammalian fauna of the Pliocene period as the district of the Val d'Arno, in Tuscany. Above the gorge of Incisa, the valley gradually expands on to Arezzo, a distance of upwards of twenty miles, forming an extensive area, which was evidently in former times occupied by a large lake. In the lacustrine deposit, and in the low hills which immediately surround it, the remains of a great Pliocene fauna are met with in immense abundance, and, regarded as a whole, in a better state of preservation, for the same number of species, than has as yet been discovered anywhere else in Europe, comprising species of Mastodon, Elephas, Rhinoceros, Tapirus, Equus, Hippopotamus, Sus, Felis, Machairodus, Hyæna, Bos, Cervus, Antilope, Lagomys, and other small mammalia. Besides innumerable remains of Hippopotamus, entire skeletons and crania of all ages of the Val d'Arno Elephant, and skeletons of *Tetralophodon Arvernensis*, have been met with, presenting the most ample materials for the establishment and distinction of the various forms. Another circumstance, especially favourable to the study of the Val d'Arno fauna as a Pliocene association, is that, according to my observation, it is entirely free from any admixture of the characteristic forms of the Post-Pliocene glacial fauna, such as the true Mammoth, the Siberian Rhinoceros, the Elasmotherium, and their Arctic associates. The Tuscan fossil fauna has been cursorily or partially examined or gleaned from by Cuvier, De Blainville, Nesti, and others; but, unfortunately for science, it has not yet been taken up as a whole, although the Grand Ducal Museum at Florence contains a collection which might form the subject of one of the most splendid and important monographs that has yet been produced on extinct mammalia. This is the more to be regretted, as the perfect condition of the Tuscan fossils would have prevented a great deal of the confusion which has arisen from the imperfect and uncertain

establishment of species, in other European countries, upon less perfect materials, involving, in numerous instances, superfluous synonyms. As we move northwards towards the Alps, the same association of mammals is presented in the Sub-Apennine Pliocene alluvium of the Valley of the Po and its affluents, with this difference, that in various parts of the great plain of Piedmont and Lombardy, between the Alps and the left bank of the Po, there is an intrusion of erratic block phenomena, which has been referred to the transporting agency of ancient glaciers, extending low down on the southern side of the Alps. But, so far as I am aware, there is no intercalation of the characteristic forms of the glacial fauna above enumerated.

When we cross the Alps and descend upon the valley of the Rhine, corresponding Pliocene alluvium is encountered in certain parts of Switzerland, containing remains of at least one of the characteristic fossil Elephants of Italy. This stratified alluvium is overlaid by a mass of erratic drift of a different age, the mammalian fossil remains when met with being also different. Lower down the valley, from Basle to Mayence, stretching on as far as Bonn, and running up the valleys of the Neckar and the Main, is the widespread Post-Pliocene fluviatile deposits of the *Lehm*, containing the remains of the true Mammoth, the Siberian Rhinoceros, and other characteristic forms of the glacial period. In the plains of Northern Germany, a corresponding association of fossil mammalia occurs in the northern Drift. Sir Charles Lyell has lately directed special attention to the case of the Hill of Kreuzberg, in the suburbs of Berlin, where remains of the Musk Ox have been found embedded in the Drift along with the Mammoth, the Siberian Rhinoceros, and species of Horse, Deer, and Ox. On the plains north of the Alps, the mammalia of the Drift fauna are presented to us without the complication of the Pliocene period; while on the southern side, in Italy, the Pliocene mammalian fauna is exhibited free from the complication of the Drift period.

On crossing the Channel to England, the phenomena, so simple elsewhere, are presented under conditions of infinitely greater complexity. On the Norfolk and Suffolk coasts, deposits of unquestionable Pliocene age are seen in the Crag and Lignite, or submerged Forest-bed. They contain the same association of mammalian species as is met with in the Sub-Apennine Pliocenes of the Valleys of the Arno and of the Po. But these British Pliocenes are overlaid by enormous beds of boulder-clay and superficial gravels, containing mammalian remains of a much later period. The principal sections exposed along the coast are subject to the wasteful

action of the sea; and as the cliffs are undermined, the remains of different ages are mingled together on the beach below. The waves wash away the incoherent matrix, leaving the fossil bones in adventitious association; and they are thus presented to the palæontologist, either in museums or by collectors, under circumstances in the highest degree deceptive. If we pass inland, say, to the Valley of the Thames, the 'high' and 'low level' gravels, the brick-earths, and other fluviatile or subaerial deposits are observed by the geologist thickening here and thinning out there, and apparently intercalated with such subtle complication that their stratigraphical extraction satisfactorily has been admitted by leading English geologists to be a matter of great difficulty. In some cases the remains of the older epoch are exhibited at the high level, while the more modern forms occur in the lower. The consequence of all this has been that it has long been a point of accepted belief among English geologists, that the long-haired and woolly Mammoth of Siberia had lived back to be a contemporary of the Mastodon in the Crag; while the *Hippopotamus major* had lived on from the period of the submerged forest, if not from the Crag, to be a contemporary of the Mammoth, the Siberian Rhinoceros, and the Musk Ox, upon the superficial gravel of the Valley of the Thames.

The obvious way of dealing with cases of this nature is to examine the conditions where they are most simple, and then to apply the results to the more complex instances. I shall adopt this course in the remarks which I have to offer on the European fossil Elephants; and first in regard to the Pliocene forms.

The most instructive instance with which I am acquainted of the occurrence of the greatest number of Proboscidean fossil species in the same deposit, under circumstances that admit of no doubt as to their common age and association, is one to which I have referred in the former part of this communication, namely, that of the *Mastodon* (*Tetralophodon*) *Arvernensis* described by E. Sismonda. The entire skeleton of the animal, spread out, was disclosed by a railway cutting between Dusino and Villafranca, at a depth of about twenty-six feet below the surface. In the same locality and in the same stratum, but a little apart from the skeleton of the Mastodon, were found fossil grinders of *E.* (*Loxodon*) *meridionalis*, *Rhinoceros leptorhinus*,[1] with stags' horns; and close upon the surface the skull of a Lagomys. In the fluvio-lacustrine matrix, along with these remains, were found species of Unio, Helix, Paludina, and Clausilia.

[1] Subsequently *R. Etruscus*, Falc.—[ED.]

The three first Dr. Eugenio Sismonda refers to *Unio pictorum*, *Helix lactea*, and *Paludina lenta*, as the nearest approximation; and the *Clausilia* he considers to be an undescribed species, which he has named *Clausilia Mastodontofila*. By the kind permission of Professor Angelo Sismonda, I was enabled to examine the Elephant remains minutely. The most important of these was a lower jaw showing both rami, and the greater part of the beak of the symphysis, with the penultimate and last molars both present on the right side. The last true molar exhibited only eleven plates, besides the front and back talons, with the distinctive characters of *Loxodon meridionalis* strongly marked, namely, the low cipher of the ridge-formula, very thick unplaited enamel, and the ridges, where intact, comparatively low, *i.e.* their height not much exceeding the width of the crown. At another point in the same stratum, near San Paolo, the railway excavations brought to light abundant remains of *E.* (*Euelephas*) *antiquus*; among these were the last upper and last lower molars of the same individual, a large adult. They all presented in a marked manner the character of this species, namely, numerous plates, high and approximated as in the Indian Elephant, the enamel much crimped, the discs of wear showing a tendency to angular expansion in the middle. The upper molars, although partly mutilated behind, still presented nineteen plates, of which the intact ones attained seven and a half inches of vertical height, with a width of three and a half inches to the crown. The right lower molar, although mutilated, still showed twenty plates. Another huge detached specimen of the last upper molar, right side, from another animal, although not quite entire in front, presented twenty-four plates, with the enormous height of eight inches, the worn surface of the crown showing all the distinctive characters of the species.[1] These teeth agreed in

[1] This specimen was carefully examined and described by Dr. Falconer in July 1856 (see page 187). Five years later, in April 1861, he again examined this specimen, and made the following note. 'The huge last upper molar (No. 7 blue ticket of Museum Catalogue), which in my old notes I had taken for a certain *E. antiquus*, strikes me now with considerable doubt. The old description in my old notes holds good generally; but the following points now strike me: (*a*) the enormous width of crown—nothing like it do I ever remember in *E. antiquus*, (*b*) enamel grooved on the cement side, but very little true crimping, and that only near the middle; (*c*) no true mesial expansion into angular loops, but a little widening, with more crimping; (*d*) the discs not so wide as in Indian elephant or in *E. antiquus*—not much wider than in some varieties of *E. primigenius*; (*e*) no marginal reflexion of the cornua of the discs; (*f*) the enamel-plates thicker than in *E. primigenius*, but not so thick as in *E. antiquus*. On the whole, this specimen reminds me of some of those doubtful ones which I saw at Rome with Sigs. Ponzi and Cosolli, and with Carlo Strozzi at Leghorn and Pisa, coming very near to *E. Armeniacus*, and left undecided.' On the same date, the following note is entered in the Note-book: 'On going over the elephant molars and

every important respect, with large grinders of *Euelephas antiquus* from Grays Thurrock, in the Valley of the Thames, which are preserved in the Museum of Practical Geology in Jermyn Street. In this case there is an unquestionable instance of the occurrence of three fossil species of Proboscideans, in nearly contiguous points of the same Pliocene stratum, and there is no ground to doubt that they were contemporaneous members of the same fauna. Near Florence, in the same district of the Astesan, and in the same deposit, tusks and molar teeth belonging to five or six individuals of Tetralophodon Arvernensis, with jaws of *Rhinoceros leptorhinus*,[1] teeth of Hippopotamus and Tapir (?), were dug up mixed with Helices, Paludinas, and Clausilias. Professor A. Sismonda, Dr. Bellardi, and Signor B. Gastaldi, all accomplished geologists intimately acquainted with the country, assured me that all these remains were yielded by the same Pliocene alluvial strata. Teeth of another Proboscidean species, *Trilophodon Borsoni*, at first taken for the Mastodon of the Ohio, to which it is closely allied, were described by Borson from the same Pliocene alluvium, in the hills near Villanova, also in the Astesan. I was enabled to examine the original specimen in the Museum at Turin. As stated in the previous part of this communication (p. 14), the specific distinctness of this form has been satisfactorily proved by the labours of Pomel and other French palæontologists, from teeth discovered in the department of the Haute-Saône, and other localities in France. Wherever it has been met with, the remains of this species are exceedingly rare, and as yet they have only been sparingly observed in Italy.

In none of the Astesan localities, so far as I am aware, have any well-determined remains of *Loxodon priscus* been discovered up to the present time. But a very fine and conclusive specimen of this rare species exists in the Natural History Museum at Milan, which I had the opportunity of carefully examining, through the obliging permission of Dr. Emilio Cornalia (see p. 101). It consists of a nearly entire last molar, lower jaw, left side, in a beautiful state of preservation, being deficient only in the anterior talon, and a portion of the first ridge, borne by the anterior fang. The crown shows twelve

comparing them with my old notes (see *antea*, p. 187), I am struck with the difference of my present impressions in respect to the predominance of *E. antiquus*, and have therefore thought it best to go over the whole of the specimens again for fresh investigation.' Dr. F., however, was still convinced of the distinctness of the specimens from the *Elephas meridionalis* of the Val d'Arno, &c. Two years later, in 1863 (in his memoir on *E. Columbi*), he expressed the opinion that many of the specimens in the Turin Museum, and also at Rome, belonged to *E. Armeniacus*. (See pp. 249–50.)—[Ed.]

[1] Written in 1857. Subsequently *R. Etruscus*, Falc.—[Ed.]

plates, all more or less worn. The discs of wear have the broad rhomboidal expansion in the middle, which is so characteristic of the existing African Elephant, with thick enamel, considerably grooved or crimped on the outer surface (that which is in contact with the cement). The enamel-edges project high above the cement, in some of the plates to the extent of seven-tenths of an inch. The tooth measures twelve inches in extreme length, including twelve plates within this space, being an average of one inch to each plate. While engaged on the examination of this specimen I had with me an accurate drawing, of the natural size, of the Grays Thurrock specimen of the same species, *Loxodon priscus*, figured in the 'Fauna Antiqua Sivalensis,' which enabled me to institute a rigorous comparison, and I found that the two specimens agreed in the closest manner, making allowance for their different stages of wear. Taking into account the constancy and significance of the rhomboid expansion in the African Elephant, as a specific distinction, and the incompatibility of the character above indicated with either *Loxodon meridionalis* or *Euelephas antiquus*, together with its close agreement with the Grays Thurrock specimens, no doubt remained in my mind that the Milan specimen belonged to *Loxodon priscus*. The mineral condition was equally conclusive of its being an undoubted fossil. That molar was discovered on Monte Serbaro, in the district of Romagnano, and valley of the Pantena, near Verona. In this locality there is a rich deposit of Mammalian bones, of the Sub-Apennine period, which has been described by Forbes. Elephant remains have been discovered in it in great abundance. Cuvier has figured a lower jaw of very large dimensions, which, so far as can be determined from an imperfect drawing, would appear to belong to *Loxodon meridionalis* (Oss. Foss., tom. i., Plate IX. fig. 8), but it may have belonged to *Loxodon priscus*. Cuvier states that the Monte Serbaro Elephant remains, which exist in the Paris Museum, indicate an animal at least fifteen feet high.

I have already noticed, in the earlier part of this paper, the Elephant remains discovered by Cortesi on Monte Pulgnasco, near Piacenza (p. 113). The principal palate-specimen is very badly represented in Cortesi's figure; but I examined it minutely, fresh after a visit to the Museum at Florence, and I found all the characters agree exactly with those of the *Loxodon meridionalis* of the Val d'Arno.

These various localities, in Piedmont and Lombardy, represent the same Pliocene alluvium of the Sub-Apennine period. It would be expecting too much, and contrary to what we find elsewhere in similar cases, to look for the occur-

rence of all the fossil forms throughout; for the points where they are disclosed are little more than specks on the common area. But the facts would seem to me to be as conclusive as most of those on which we do not hesitate to reason in geology, that five species of Elephantine Proboscidea were co-existent at the same epoch in Piedmont and Lombardy; namely, two Mastodons, *Trilophodon Borsoni* and *Tetralophodon Arvernensis*, and three Elephants, *Loxodon meridionalis*, *Loxodon priscus*, and *Euelephas antiquus*.

In the earlier part of this communication I have already referred to the association of Pliocene Mammalia in the Val d'Arno. The Proboscideans which are found most abundant there being *Tetralophodon Arvernensis* and *Loxodon meridionalis*, along with *Rhinoceros leptorhinus*,[1] *Hippopotamus major*, and other forms, herbivorous and carnivorous, characteristic of the Sub-Apennine period.

In the Roman States, Elephant remains have been met with in strata of the same age, mingled with those of *Rhinoceros leptorhinus*, *Hippopotamus major*, and various other Mammalia. The Elephants have hitherto been referred by all or most authorities to the mammoth, *Eleph. primigenius*. But Cuvier, under that name, has figured and described a lower jaw from Monte Verde, which I refer to *Loxodon meridionalis*.[2] Professor Ponzi, of Rome, has given an enumeration of the genera and species in a communication to the Scientific Association of Italy, in 1847. He refers all the Elephant remains to *Eleph. primigenius*, and divides the fauna into three groups, Pliocene, newer Pliocene and Modern. No specimens of Mastodon remains, so far as I am aware, have been described from this part of Italy.

The only other foreign locality to which I shall refer for a term of comparison is one of great interest in France, in the Beauce, near Chartres, brought to light by a railway-cutting within the last few years. Chartres is situated on the plateau which separates the water-sheds of the Seine and of the Loire. The line of excavation passed through a fluviatile deposit of gravel, sandy loam, and brick earth, abounding in remains of Elephants, Rhinoceros, Hippopotamus, and other large herbivorous quadrupeds.

A fine collection of these remains has been formed in the Duc de Luynes' Museum at Château Dampierre, by Mons. Gory, to whose obliging kindness and liberality I was indebted for an opportunity of examining them in detail. The Elephant remains are numerous, consisting of molars, tusks, bones of the extremities, and other parts of the skeleton.

[1] See note, p. 193.—[Ed.]
[2] Ossemens Fossiles, Éd. 3me., tom. i. p. 165, Pl. ix. fig. 3.

The molars were all of adult or well-grown animals, and must have been derived from many individuals. I observed no milk-teeth among them. Many of the teeth are in fine preservation, thus admitting of easy specific identification. With one doubtful exception they were all of *Loxodon meridionalis*. The ridge-plates on the last lower molar, where entire, never exceeded thirteen or fourteen in number. The other characteristic marks of the Val d'Arno species are all well exhibited; namely, thick distinct digitations to the plates, with very thick unplaited enamel, and the height of the intact plates not much exceeding the width of the crown. The doubtful specimen is a fragment of a very old molar of the lower jaw, worn down to the base, which in some of the plates presented discs of wear having a rhomboid mesial expansion, four-fifths of an inch broad, very much like those of *Loxodon priscus*. But the very advanced wear and fragmentary condition of this specimen left the specific determination of it uncertain. The associated herbivorous mammals were *Rhinoceros leptorhinus*,[1] *Hippopotamus major*, with large bovine and cervine ruminants, with terete-branched antlers, of species which during my short visit I was unable to determine. Mons. Du Bois Villette, of Chartres, has made an extensive collection of these remains, and some very fine molars of *Loxodon meridionalis* presented by him are displayed in the Museum of the École des Mines at Paris. One to which I would refer is a superb specimen of a last upper molar of the left side, showing eleven of the ridges worn. The association of the mammalia, so far as it extends, in this case is clearly that of a Pliocene Fauna; but the special interest in its bearing on the English deposit lies in this, that while the mineral characters of the bed and its contained fossils present a close general agreement with those of Grays Thurrock, the prevailing Elephant is a species which, so far as I am aware, has not yet been detected in the brick-earth deposits of the Valley of the Thames.

I shall now consider the general conditions of the principal deposits in which Elephant remains occur in England. In the preceding part of this paper I have stated the grounds for considering the Crag Mastodon to be a Pliocene species, and the associated contemporaneous mammals, so far as they have been well determined, as being likewise Pliocene. As the Crag constitutes the lowest geological level in which Elephant remains occur in England, it is of importance that the species should be carefully identified. A characteristic specimen of *Euelephas antiquus*, from the Red Crag of Felix-

[1] See note, p 193.—[Ed.]

stow, exists in the Geological Society's collection; there are others in the Museum of Practical Geology, and in various collections in Norfolk which I have examined. Of *Loxodon meridionalis* a very characteristic and decisive specimen is represented in the 'Fauna Antiqua Sivalensis' (Plate XIV. B. figs. 18 and 18 *a*).[1] It was discovered in the Mammaliferous Crag near Harwich, and consists of the last lower molar, right side, having twelve ridges, along a length of twelve inches. The ridges are comparatively low, their height, where intact, not much exceeding the width of the crown. The digitations are thick and distinct for a considerable distance below their apices; and the plates of enamel very thick. The ridges are so thick that they average one to an inch. In the aggregate the characters approach very closely to those of the equivalent teeth in *Loxodon planifrons* of the Sewalik hills. The specimen is highly ferruginous, like most of the Crag bone-remains. Two other specimens, which I have examined from the Crag, presented by Miss Anna Gurney to the Paris Museum, are figured by De Blainville. They are 'intermediate molars' of *Loxodon meridionalis*. Various other illustrations might be cited, but I confine the references to figured specimens. These Crag specimens respectively of *Loxodon meridionalis* and *Euelephas antiquus* differ in no material respect from specimens of the same species above referred to as occurring in the Italian Pliocenes.

The highest level in which *Tetralophodon Arvernensis* occurs in British strata has not yet been accurately ascertained. In the remarkable case of the entire skeleton recorded by Mr. Layton as having been discovered at Horstead, 'stretched out between the chalk and the gravel,' it has not yet been clearly made out whether the bed is an equivalent of the Crag or above it. The locality has been examined conjointly by Messrs. Godwin-Austen, Prestwich, and Morris; and Mr. Austen assures me that there is no doubt about the authenticity of the case, and that the skeleton was certainly of a Mastodon. The bones of the herbivorous mammals occurring in the Crag are invariably presented in a condition more or less fragmentary, as if they had been washed out of a pre-existing Pliocene land and deposited in a reconstructed sea-bottom. A slight oscillation of the relative levels of the land and sea would admit of this being effected within a comparatively limited period. Having regard to the undisturbed and compact state in which the Horstead skeleton lay, it may be inferred that the deposit was either on a higher level than the Crag, or that the breaching action of the Crag-waves had

[1] See vol. i. p. 447, and vol. ii. Pl. viii. fig. 1.—[Ed.]

not reached it. No Mastodon molars have yet been discovered *in situ* in the fluviatile and lacustrine strata on the Norfolk coast above the Crag; but after a careful perusal of the various recorded instances where teeth have been met with on the beach, below undermined cliffs, I am not satisfied that they were in every case derived from the Crag and not from the superincumbent Clay or Forest-bed. The age, so long assigned to the Crag Mastodon, naturally disposed geologists and collectors to refer the doubtful cases to the oldest strata.

The next beds in the order of superposition, yielding Elephant remains, are the freshwater deposits composing the mud-cliffs of Eastern Norfolk, which have been examined in great detail by Sir Charles Lyell and other English geologists; while the mammalian remains have been investigated by Professor Owen. I have had opportunities of studying a very large number of the Proboscidean fossils of these beds, in the collections at Norwich, and in the various collections, public or private, in London, and I have lately been indebted to the obliging kindness of the Reverend John Gunn for a fine series which he has transmitted to me for illustration on the present occasion. So far as my observation has gone, the species have invariably proved to be either *Loxodon meridionalis* or *Euelephas antiquus*, and among the associated pachyderms *Rhinoceros leptorhinus* and *Hippopotamus major*. A vast number of Elephant grinders have been found along the coast, near Happisburgh, Mundesley, and Cromer. The collection of Miss Gurney has acquired a celebrity for its richness in these remains. Molars of *Euelephas primigenius*, the Siberian Mammoth, are occasionally picked up upon the beach, mingled with the other species, especially below the Cromer cliffs; but the admixture would seem to be merely adventitious, from the Mammoth grinders having fallen out of the superincumbent drift or gravel. They are usually in a different mineral condition from the more ancient remains, and readily distinguishable.

The Elephant molars, from the Norfolk mud-cliffs, both of *Loxodon meridionalis* and *Euelephas antiquus*, occur in two very different states of mineralization. Those from the gravel-banks of Happisburgh and Mundesley exhibit generally a reddish-brown colour, from ferruginous infiltration; and when they have been subjected to the action of the sea they usually show more or less of a vitreous polish. They are hard, heavy, and compact, with a specific gravity of 2·73, as compared with 2·08 in the recent molar of the Indian Elephant, while grinders from the blue clay of Cromer adhere to the tongue and give out a strong ammoniacal odour when burnt. I have

as yet seen no well-marked remain of *Loxodon priscus* from these beds, which I regard, from the mammalian contents, as being of the same age as the Sub-Apennine Pliocene alluvia.

The next Elephant-yielding bed which I shall notice is the 'mud-deposit' of Brackelsham Bay and Pagham Harbour, described by Mr. Dixon, and ably investigated lately by Mr. Godwin-Austen. It consists of a fine dark-coloured sandy mud, of great firmness and tenacity, lying upon the Eocene blue clay, and in some places attaining a thickness which Mr. Austen estimates at eighteen or twenty feet. He enumerates thirty-eight species of marine Testacea, and 'the character of the whole assemblage,' he states, 'is essentially southern and western.' He considers that the 'mud-bed' is either an old estuary or an 'enclosed salt-water lagon' deposit, formed under conditions of comparatively high temperature. The only mammalian remains which it was supposed to yield were those of *Elephas primigenius*. But during a late visit to Brackelsham Bay, in company with Sir Charles Lyell and Mr. Godwin-Austen, the Rev. Robert Everest and myself, after a few minutes' search, picked up a well-marked tibia of a small *Equus* and another bone. The dark-coloured bones are not obvious in the dark mud, and the attention of the local collectors has been habitually so much directed to looking out for fine specimens of *Pholas* and *Lutraria*, that the bone-remains have been to a great extent overlooked. When a closer search is instituted abundant mammalian remains may be expected. A considerable collection of Elephant-grinders from the 'mud-deposit' exist in the Chichester Museum. They are mostly in fine preservation, and after a careful examination the whole of them proved to be of *Euelephas antiquus* (pp. 181–4). I found no teeth of the Mammoth among them. In this case the mammalian evidence, so far as it goes, agrees with the shells in indicating the 'mud-deposit' to be of the Sub-Apennine age, and it may prove to be one of the oldest Pliocene beds in England.

I shall next consider the fluviatile deposits of the Valley of the Thames, in relation to their Elephantine remains. These freshwater strata occur at various points along the valley, such as Brentford, Grays Thurrock in Essex, and other localities. 'They consist of sand, gravel, and loam, from 60 to 100 feet thick, and often form a terrace on each side of the valley, rising to a much higher level than a vast bed of more modern gravel.'[1] This ochreous gravel, says Sir Charles Lyell, whose description I quote, extends from east to west,

[1] Annals of Nat. Hist. 1836, vol. ix. p. 261.

from above Maidenhead to the sea, for a distance of fifty miles, having a width varying from two to nine miles, and a thickness of five to fifteen feet. It is spread out over the lower levels of the valley, containing in it the remains of Arctic animals. Sir Charles Lyell considers it quite clear that it was deposited after the fluviatile beds were formed. The most instructive of these freshwater deposits, as having yielded the largest number of mammalian remains, is that of 'Grays Thurrock,' described by Mr. Morris in 1836. The section is exposed to a depth of about forty-seven feet, consisting of beds of mould, loam, and at the bottom sandy clay abounding in freshwater shells. Numerous Elephant remains, with those of other mammalia, have been discovered in the lowest beds containing the shells; they are rarely found above it. Among these was a nearly entire skeleton of an Elephant, of which two large grinders were preserved. One of these is now in the British Museum; the other was in the possession of Mr. R. Meeson, the proprietor of the brick-field. The first is represented in the 'Fauna Antiqua Sivalensis,' Plate XIV. fig. 7.[1] Unfortunately it is mutilated at the anterior extremity, depriving us of direct evidence as to the complete number of the crown-ridges. The crown was in full wear, showing seven ridges and a talon. One or two ridges in front, supported by the large anterior fang, are wanting. The tooth is inferred to have been the penultimate or second true molar, lower jaw, left side. It measures 7·8 inches, comprising in all eight plates (talon inclusive), being an average of about one plate to an inch. The discs of wear present a rhomb-shaped outline, wide and angular expansion in the middle, and thick enamel, closely resembling the same characters in the African Elephant. The specimen was sawn up to expose the internal structure, and the relative proportions of the different constituent materials exhibit the same general resemblance to the African Elephant. The mineral condition of the specimen puts it beyond question that it is an undoubted fossil. I have stated above how closely I found the Monte Serbaro fossil grinder correspond in all its characters with the Grays Thurrock specimen. Another fossil grinder from the same deposit is represented in the 'Fauna Antiqua Sivalensis,' Plate XIV. fig. 6. It is mutilated at both extremities, showing only six discs, less advanced in wear.[2] All these specimens I refer to *Loxodon priscus*. Remains of *Euelephas antiquus* also occur in the same bed at Grays Thurrock, differing in no material respect from grinders of the same species, occurring in the Astesan, in the Crag and in the Nor-

[1] See vol. i. p. 441, and vol. ii. Pl. vii. figs. 1 and 2.—[Ed.]
[2] See vol. i. p. 441.—[Ed.]

folk freshwater Clays. A superb specimen of the last upper molar, left side, of this species, from Grays Thurrock, showing sixteen of the anterior plates (the back portion being wanting), is deposited in the Museum of Practical Geology. It presents all the marked characters of the species. In 1846 I made an excursion along with the late Professor Edward Forbes to Grays, with the express object of examining the Mammalian contents of the bed, and on that occasion I saw other specimens of *Euelephas antiquus*, which had been recently exhumed. No remains referable to *Loxodon meridionalis* from any of the fluviatile deposits of this age, in the Valley of the Thames, have as yet come under my observation, although it occurs in the Beauce at Chartres, along with the same association of Mammals. A similar deposit occurs near Brentford, the fossil remains of which were first brought to notice by Mr. William Kirby Trimmer, in a paper in the Philosophical Transactions for 1813. Excellent figures, by Basire, are given of two fossil Elephant grinders, the one of the upper and the other of the lower jaw, which Mr. Trimmer refers respectively to the Indian and African Elephants. They are certainly not of the Mammoth, and appear to me to belong to *Euelephas antiquus*. There is an old specimen in the Museum of the Royal College of Surgeons, No. 570 of the Catalogue, presented by Sir Joseph Banks, from Brentford, which belongs to the same species. The same collection contains other remains of this species, from Walton in Essex, presented by Sir William Blizard, and from Ilford, by Mr. John Gibson, besides specimens of which the localities are unrecorded.

The larger Mammalia associated with the Elephants in Grays Thurrock are *Rhinoceros leptorhinus*, *Hippopotamus major*, Horse, Cervus, Bovine Ruminants, and Ursus; at Brentford. *Rhinoceros leptorhinus*, *Hippopotamus major*, Ox, and Deer. Mr. Morris, in a later paper, describes a section near Brentford yielded by a railway cutting 100 yards north of Kew Bridge. Eight layers or strata, more or less distinct, are exposed, the five inferior containing Mammalian remains, of which Mr. Morris gives the following enumeration:

1. Elephas primigenius.	5. Bos longifrons.
2. Rhinoceros tichorhinus.	6. Cervus Tarandus.
3. Hippopotamus major.	7. Cervus Elaphus.
4. Bison priscus.	8. Felis spelæa.

I consider the association here indicated, assuming that the identifications are exact, to be in the highest degree improbable, as of animals that were coexistent at the same

period. It would seem intelligible only on the supposition that the section includes beds of different ages. I have never seen a tooth of the true Mammoth among those of *Loxodon priscus* and *Euelephas antiquus*, from the fluviatile deposits in the Valley of the Thames.

It is beyond the scope of this communication to discuss the nature of the Elephant remains occurring elsewhere in deposits more or less analogous to those of the Valley of the Thames, such as in the Valleys of the Stour, the Medway, the Arun, the Avon, the Severn, and other localities in England. I have thought it sufficient to restrict the inquiries on the present occasion to the range between the Crag on the one hand and the Thames Valley fluviatiles on the other; and to confine the comparison to a few well-marked and significant forms. Regarded by the light of their common mammalian fauna, they appear to me alike to belong to the same Pliocene age.

The detail, into which I have entered in the preceding remarks upon the range and associated mammalia of the other European fossil Elephants, relieves me from the necessity of dwelling much upon the conditions under which the last and most modern species, *Euelephas primigenius*, or the true Mammoth of Siberia, is met with in British strata. The thin, parallel, closely arranged, and uncrimped plates of enamel, with the attenuation of the other dentary constituents, disposed like the teeth of a fine comb, readily distinguish, in the view here taken, the fossil grinder of the Mammoth from those of the other species. And wherever teeth presenting these characters are observed it will, I believe, be invariably found that they occur in deposits of a more recent geological date than the Pliocene fluviatile beds; and that they are never mixed up, except adventitiously, in the same fauna with the other species. In the preceding observations I have referred to the association of species which is presented by the wide-spread loess of the Rhine, and the superficial drift of the plains of Northern Germany, where Mammoth remains are found in company with those of *Rhinoceros antiquitatis*, horse, musk-ox, reindeer, and other northern forms. In the plains of Northern Russia and Siberia, to this group the rare Elasmotherium is added, which, there are plausible grounds for believing, ranged as far as the Rhine. The characteristic Sub-Apennine forms, such as the *Rhinoceros leptorhinus*,[1] *Hippopotamus major*, or any of the three Pliocene Elephants, are nowhere discovered among them. In like manner, the remains of the Mammoth occur in the superficial gravels which are so

[1] See page 206, *note*.—[Ed.]

generally spread over England, and in the erratic beds to which the names of 'Northern Drift' and 'Till' are applied. The fauna would appear to consist of the same forms as in the northern drift of Germany, namely, *Rhinoceros antiquitatis*, equus, musk-ox, rein-deer, and other ruminants. Unlike the Pliocene elephants, of which entire skeletons, with the bones in more or less contiguity, have been observed in the freshwater fluviatiles, the Mammoth remains generally occur detached and scattered in the gravel, and I think it worthy of inquiry whether a well-authenticated case is on record of the bones of a Mammoth skeleton, collected together in one locality in British Post-Pliocene deposits, and if so, under what circumstances the case was presented. Unrolled crania of the Mammoth have been procured from the loess of the Valley of the Rhine. In one instance which I have examined, at Mannheim, the skull is very perfect, the bones fresh-looking and full of undecomposed gelatine. Buckland states, 'that at Kingsland, near Hoxton, in 1806, an entire elephant's skull was discovered, containing two tusks of enormous length, as well as the grinding teeth;' but no particulars are given by which the species would be determinable. Detached Mammoth remains have been found in the Till in Scotland. At Clifton Hall, between Edinburgh and Falkirk, a Mammoth tusk was discovered so fresh that it was fit for the manufacture of chessmen. (Werner. Trans. vol. iv. p. 58.) Another was discovered in a mass of diluvial clay at Kilmaurs in Ayrshire, near the water of Carmel. Mr. Smith, of Jordan Hill (in his Memoir on the 'Changes in the Relative Levels of the Sea and Land,' p. 35), cites several other instances of Mammoth remains from the Till in the southern and western parts of Scotland. It would be tedious to enumerate all the localities where they have been discovered in England. I will merely mention a few cases of special interest. One of these is the 'elephant-bed' of Dr. Mantell at Brighton. I have examined a grinder from his collection now in the Jermyn Street Museum; it is labelled as being from the chalk-rubble, is very fresh-looking, and presents the characters of the Mammoth in a marked manner. Another locality of interest, and demanding great care in the observation, is the series of gravels described by Mr. Godwin-Austen, as lying upon the 'mud-bed' of Brackelsham and Pagham Bay. Here the teeth are constantly exposed to being washed out of the gravel and embedded in the mud-bed along with the *Euelephas antiquus* molars which belong to it. I have seen very characteristic specimens of Mammoth grinders from Kingsland.

As regards the relative abundance of remains of the four

fossil species, according to my observation, in England they would run in the following order.

1. E. (Euelephas) antiquus.
2. E. (Euelephas) primigenius.
3. E. (Loxodon) meridionalis.
4. E. (Loxodon) priscus.

The teeth of *Euelephas antiquus* are excessively abundant in the freshwater deposits on the Norfolk coast. Of the two thousand Elephant grinders which Mr. Woodward estimates to have been dredged up within thirteen years, from the oyster-bed near Happisburgh, I believe that by far the largest number belonged to this species. The next, in point of number, are those of the true Mammoth, from the wide-spread drift and gravel-beds. Teeth of *Loxodon meridionalis* are much less frequent. They occur in the Norwich Crag, and at Happisburgh and Mundesley. The only inland specimen attributable to this species which I have as yet met with is the Staffordshire specimen described by Parkinson, and of which there is a beautiful figure in the British Fossil Mammalia (fig. 93, p. 239). Professor Owen, in describing it, states that he had 'seen a very similar molar of the Mammoth from the Norfolk freshwater deposits, in the collection of Mr. Fitch of Norwich' (*loc. cit.* p. 240). The Elephant remains found so abundantly at Cropthorne, and at Deptford and Eckington, in the Valley of the Avon, and along with bones of Hippopotamus, &c., and freshwater shells by Mr. Strickland, have not yet been precisely determined. Supposing the record by Parkinson to be exact, I shall not be surprised if among the Avon remains teeth of *Loxodon meridionalis* turn up, presenting a case analogous to that near Chartres, already referred to. The rarest species of all is *Loxodon priscus*, of which only one English locality, namely, Grays Thurrock, is known; and the specimens which have been found there are all but unique. If this excessive rarity be considered as furnishing any grounds for questioning the reality of this extinct species, as distinct from the other, I refer to the parallel case of the solitary molar of *Trilophodon Borsoni*, found in the Astesan. This form was never confounded with *Tetralophodon Arvernensis*, but with *Trilophodon Ohioticus* of North America. It is now universally accepted by the modern palæontologists of France, where it occurs in most abundance, although still rare. The presence of *Loxodon priscus* in British strata is of great interest, and I would recommend it as an object of praise-

[1] Geological Transactions, 2nd ser. vol. iv. p. 555.

worthy research to English geologists and collectors, who have access to local museums, in which the remains of the Essex fluviatile deposits are preserved. (See page 251, *note* 1.)

It has been objected to me by naturalist friends of eminence, and for whose opinions I entertain the highest respect, that there is a *primâ facie* improbability that so many Proboscidean species should have co-existed in the same Pliocene fauna, namely, two Mastodons and three Elephants. My reply is: First, go and examine the evidence in the Astesan, where abundant remains of three of the species occur within a limited area in the same alluvium, mixed up with the same freshwater shells; then examine the extension of the same deposits near Piacenza and Verona; then the deposits of the Val d'Arno; and compare the association of mammals in each. Secondly, the Miocene fossil fauna of the Sewalik hills (exclusive of Ava and of the Nerbudda Pliocene beds) presents a parallel case, where at least six fossil species of Proboscideans are met with in beds of the same age, in the same matrix, the same mineral condition, and with the same associates; namely, two Mastodons, *Tetraloph. latidens* and *Tetraloph. Sivalensis*; two Stegodons, *Steg. bombifrons* and *Steg. insignis*; one Loxodon, *Lox. planifrons*; and one Euelephas, *Euel. Hysudricus*. Of five of these forms, crania exist in the British Museum, besides the details of their dentition; and the evidence of their distinctness, founded on these crania, is quite as conclusive as that upon which palæontologists would distinguish the existing Elephant from the Mastodon of North America, by the form of their skulls.

From the consideration of the various facts which I have passed under review, I have been led to the conclusion that the same mammalian fauna ranged throughout, from the Crag up to the Thames Valley fluviatile deposits, and that any division of them into older and newer Pliocenes, as Pleistocenes and Post-Pliocenes, is untenable. It would seem to me that in all the investigations where the classification of the newer Tertiaries is concerned, too much stress has been laid on the shell-evidence, while that which may be derived from the mammalia has been in a great measure either overlooked or undervalued. Like the artificial arrangement of Linnæus in plants, the shell-evidence has furnished a ready and convenient means of arranging the strata conventionally in successive order, regarded from one aspect; but it can never satisfy the requirements of a natural philosophical system, where the solution of the conditions of the higher forms of terrestrial life constitutes the most important part of the problem. The evidence must be taken from every side,

and weighed according to the relative value of the facts. That which is furnished by the mollusca has been everywhere abundantly investigated. I shall now briefly examine the mammalian aspect. In the Italian Pliocenes, where the fauna is most concentrated, two Mastodons and three Elephants, with probably two Rhinoceroses and one Hippopotamus, are met with as leading and characteristic forms. All the Proboscidean forms are not uniformly distributed throughout; sometimes three or four, and sometimes two, or only one, of the species are met with, but in every instance accompanied by *Rhinoceros leptorhinus*, and *Hippopotamus major*. The presence or absence of the leading species of Mastodon, namely, *Tetralophodon Arvernensis*, does not appear to be of positive significance, since it has either not been found, or only very rarely, in the Pliocenes around Rome, where the same fossil elephants, *Rhinoceros* and *Hippopotamus*, with their associates, occur, as in the Sub-Apennine beds proper. In the English deposits, taking the range from the Crag up to the fluviatile beds of Grays Thurrock, four of these fossil Proboscidea, with the same *Rhinoceros leptorhinus* and *Hippopotamus major*, are met with.[1] The two latter pachyderms occur uniformly throughout from the level of the submerged Norfolk lignite bed on to Grays Thurrock. Of the Proboscidean forms, *Euelephas antiquus* occurs everywhere from the Red and Norwich crags, through the submerged forest and Norfolk Lacustrine clays; the Brackelsham 'mud-deposit;' and the Thames fluviatiles at Grays Thurrock, Brentford, and other localities. *Loxodon meridionalis* occurs in the Crag and in the Norfolk clays along with *Euelephas antiquus*. But it has not yet been met with in the Thames fluviatiles, although occurring in a corresponding deposit at Chartres in France, and apparently in some fluviatile beds in Staffordshire or the contiguous central counties. *Loxodon priscus* has only been found at Grays Thurrock in company with *Euelephas antiquus*; and *Tetralophodon Arvernensis*, in the Red and Norwich Crag, along with *Loxodon meridionalis* and *Euelephas antiquus*.

There is no obvious reason in nature why more importance should be attributed to any one of these Proboscidean forms than to another, as tests of geological age. The Crags contain one Mastodon and two Elephants, common to them and the Sub-Apennine beds of the Astesan; while Grays Thurrock contains two Elephants, with *Rhinoceros leptorhinus* and *Hippopotamus major*, common to it and the beds of the Astesan and Lombardy. These facts would seem to me to be conclusive that all these Pliocene alluviums supported the

[1] This was written in 1857, before the Author separated *R. Etruscus* and *R. hemitæchus* from the *R. leptorhinus* of Cuvier.—[Ed.]

same mammalian fauna, and that they belonged to one geological period. It is not meant to be implied that all the species of the fauna ranged equally everywhere throughout the area; some in all probability predominated in the south, others in the north; but I can see no grounds for entertaining the belief that they were broken up into groups in successive periods, corresponding with an older Pliocene, Pleistocene, and Post-Pliocene division.

In speculating about the probable climatal conditions on the land in Europe during the Pliocene period, one of the fossil pachyderms has appeared to me capable of throwing more light than all the others, namely, *Hippopotamus major.* Two living species of this genus are known, the one *Hippopotamus amphibius*, the other the small *Hippopotamus Liberensis.* They are both found in the tropical or warmer parts of Africa. In their habits they are strictly aquatic, plunging into rivers during the day, and emerging at night to pasture along the banks. They always hug the margins of the rivers or lakes, and are not known to make inland journeys away from them. When they migrate, they either float with the stream, or, if moving against it, they walk along the beds of the river, only leaving it for a short distance, when their course is interrupted by rapids, and replunging into the stream when the obstacles cease. Wherever they are found they enjoy open water all the year round. Their unwieldy heavy form and short limbs are admirably adapted for their aquatic habits, but unfit them for journeying by land.

There is no reason to believe that the huge European fossil species was in any respect less aquatic in its habits than its living congeners. Wherever its remains have been discovered in the greatest abundance and perfection, it has invariably been along the margins of rivers or great lakes, such as the Val d'Arno, where the bones of hundreds of individuals have been observed. It appears to have been spread over nearly the whole of the Pliocene area of England, since bones and teeth have been described from the Valleys of the Severn, the Avon, and the Thames, Kirkdale Cave, Kent's Hole, and Durdham Down. The general argument, so ably discussed by Dr. Fleming, that we cannot predicate in many cases from the known food and habits of existing species, what the food and habits of extinct species of the same genus may have been, will not apply to the fossil *Hippopotamus major*, which must have had open water free from ice, if it lived the whole year round in England. That it was capable of migration by land more than the existing species we have no grounds for believing; and if it is argued that there may have been

large rivers flowing from the south during the Pliocene period, along the course of which the Hippopotami could have migrated during winter, the argument might apply to the population of one or two river-valleys, but it would hardly extend to the Hippopotami spread over the broad area of England. In balancing these various considerations, it seems to me most probable that the *Hippopotamus major* was a permanent resident of the country during the Pliocene period. This would involve a comparatively warm temperature throughout the year as late as the deposition of the 'Grays Thurrock' beds, and the same would seem to be indicated by the presence of some southern freshwater shells, which are now extinct in England.

It is at the present time very generally accepted among geologists that there are good grounds for believing in a continual refrigeration of climate during the Pliocene period in Britain. But this can only be entertained as holding good in regard of the sea. The terrestrial evidence furnished by the general characters of the mammalian fauna gives no countenance to a corresponding reduction of temperature on the land. It may be possible to reconcile the opposed indications by supposing that while the removal of an ocean barrier in the form of islands to the north admitted the gradual migration of Arctic marine forms, and repelled Mediterranean species to more southern localities, still the climatal conditions of the land may not have been altered in the same proportion. One cause of this may be sought for in the unbroken continuity of land between England and the Continent during the Pliocene period, which would have contributed to counterbalance the effects produced by the decreasing temperature of the sea.

I shall now briefly review the opinions of some English geologists who have been more especially engaged in researches upon the newer Tertiaries. Mr. Searles Wood, in the introduction to his admirable monograph of the Crag Mollusca, after giving the division, at the time generally prevalent, of three different periods in the formation, namely, the Miocene *coralline crag*, Pliocene *red crag*, and Pleistocene *mammaliferous crag*, states his opinion that, upon the shell evidence, the lacustrine or fluviatile deposit of Grays, Clacton, and Sutton, were probably the freshwater equivalents of the Red Crag, while the Copford deposit may be of a more modern date.

Mr. Prestwich, in his note on the gravel near Maidenhead, after describing the lithological characters and range of the mass, refers to the Brentford bed, and to the fossil bones discovered there by Mr. W. Kirby Trimmer, in 1813, as pertaining to it. With regard to the age of the gravel, he states

his opinion that 'it belongs doubtfully to the same period as the Kingston, Brentford, Kew, and London beds, which I am inclined to consider as among the most recent of our drift-deposits, and as posterior to the period of the great boulder-clay of Norfolk and Suffolk; but the relation of these beds is nowhere clearly seen:' and he adds that this question of relative age depends on a variety of collateral evidence which he hopes to lay before the Society at a future period.

It would be presumptuous in me to question the stratigraphical results of a distinguished practical geologist, so eminent for his profound knowledge of the tertiary formations as Mr. Prestwich. But if by the passage I have cited it is implied that the Brentford fluviatile strata containing the mammalian remains described by Mr. W. Kirby Trimmer and other beds of the same age, in the Valley of the Thames, are of a later age than the boulder-clay, the conclusion is entirely at variance with the mammalian fossil evidence, and would involve the startling corollary that, after the Norfolk lacustrine beds had been submerged for a long term of the glacial period, during which enormous deposits of boulder-clay and till were accumulated above them, the Pliocene mammalian fauna again reappeared on the emerged surface with a restoration of all the warm climatal conditions. I believe that it will be found that, while the Thames Valley fluviatiles at Grays Thurrock and elsewhere form a terrace on either side of the valley on a higher level than the 'valley' or mammoth gravel spread out below at Brentford, or in its immediate vicinity, the gravel-beds are in direct superposition to the fluviatile strata, and that the mammalian remains found there belong to two distinct geological ages, according to the depth below the surface of the bed from which they are exhumed. These upper gravel-beds I believe, with Mr. Prestwich, to belong to a date posterior to the boulder-clay and till. The enumeration of the Brentford fossil mammalia given by Mr. Morris includes both the Pliocene and the Post-glacial fauna. I have seen grinders both of *Euelephas antiquus* and of the true Mammoth from the Brentford section.

Mr. Joshua Trimmer, in his memoir entitled, 'Generalizations on the Erratic Tertiaries of Norfolk,' among other results gives the following important conclusion:—That with regard to mammalian remains, 'We have two elephantine periods, one preceding the submergence of the erratic period, and the other inhabiting the country at the close of the period of elevation. To the former are to be referred the mammalian Crag, and the remains of the bone caverns in general; to the

latter the freshwater beds of the Valley of the Thames, of the Avon in Worcestershire, of Gaytonthorpe, and of the Bielbeck in Yorkshire, together with the marine deposit of the Valley of the Nar.' This generalization is open to the same grave objections just now stated—namely, that it is directly opposed to the mammalian evidence, and would imply the intercalation of the boulder-clay and till between the Norfolk lacustrine and the Thames Valley fluviatiles, whereas the mammalian remains and shells alike would seem clearly to indicate that the Grays Thurrock beds were deposited anteriorly to any portion of the boulder-clay and till. Mr. Trimmer's general expression of there having been two Elephantine periods is correct, but not so the positions which he assigns to them. The Pliocene Elephants preceded the glacial period, while the Mammoth and its associates inhabited the country after the emergence of the land, and in all probability during the decline of the glacial period.

It was my intention to have entered in some detail on the circumstances under which Elephant remains are met with in the bone-caves properly so-called, and in the cavernous fissures; but the length to which this communication has already extended deters me from the discussion of so large a subject on the present occasion. I shall merely observe now that I believe the caves, like the lacustrine deposits and gravels, furnish evidence of Elephants of two distinct faunas, both in England and in France. In the Cefn and Kirkdale caves, for example, remains of *Euelephas antiquus*, and in every instance of young animals, have been discovered; while the fissure cavern of Kent's Hole has yielded grinders of the true Mammoth, both of young and old animals. If the two faunas have inosculated it is in some of those caves, which have been inhabited during both periods, where the most decisive proofs will be found.

With regard to the geographical range of the true Mammoth, my inquiries have led me to the conclusion that although still of vast extent it is much more limited than the area hitherto assigned to it. The result of my observation is that it never extended to the southern side of the Alps, although met with in the great valley of Switzerland. This result I am desirous of stating with the diffidence and reserve with which a negative fact involving any generalization ought always to be expressed. The grounds upon which it is rested are these:—That, after a very careful search among the collections at Florence, Turin, Milan, and Pavia, with the assistance of Messrs. Angelo Sismonda, Bellardi, Cornalia, and Crivelli, respectively in these different cities, I never met with a single grinder of *Euelephas primigenius* which was not

traceable to a foreign origin;[1] whereas, on crossing the Alps, Mammoth grinders are not unfrequent in the Swiss collections. In the Pliocene alluvium of Dürnten (alluvium of the Swiss geologists) I found that molars of *Euelephas antiquus* are met with. Well-marked specimens exist in the Museum of Zurich, which I was enabled to examine by the kind permission of M. Escher de la Linth. In the erratic bed, above this alluvium, the remains of the true Mammoth occur.

In like manner I believe that the Mammoth remains found in the United States of America are confined to the more northern and central States. Twelve years ago I pointed out to Sir Charles Lyell that some Elephant grinders which he brought from Georgia belonged to an extinct species, distinct from the Mammoth. These remains occur in the New Brunswick Canal, along with remains of Megatherium, Mylodon, Mastodon, and Horse. I have seen other remains referable to the same species from Alabama, Florida, Mexico, and Texas. To this American fossil species I have assigned the name of *Euelephas Columbi*.

[1] The author subsequently found reason to modify this opinion. See pp. 173, 175, and 241.—[Ed.]

III. ON THE AMERICAN FOSSIL ELEPHANT OF THE REGIONS BORDERING THE GULF OF MEXICO (E. COLUMBI, Falc.); WITH GENERAL OBSERVATIONS ON THE LIVING AND EXTINCT SPECIES.[1]

INTRODUCTORY REMARKS—DENTITION OF E. COLUMBI—RANGE OF HABITAT AND GEOLOGICAL POSITION OF E. COLUMBI—ASSOCIATED FOSSIL MAMMALIA—SYNONYMY OF AMERICAN FOSSIL ELEPHANTS—RANGE IN TIME OF THE MAMMOTH—ITS EARLIEST HEAD-QUARTERS—PERSISTENCE OF ITS DISTINCTIVE CHARACTERS—UNITY OR PLURALITY OF SPECIES OF EXISTING INDIAN ELEPHANT—ASSERTED OCCURRENCE OF MASTODON IN AUSTRALIA—FOOD OF LIVING AND EXTINCT ELEPHANTS:—A. OF THE INDIAN ELEPHANT—B. OF THE AFRICAN ELEPHANT—C. OF THE MAMMOTH.

§ 1. INTRODUCTORY REMARKS.

MY first knowledge of this form dates from the year 1846, when Sir Charles (then Mr.) Lyell submitted to me, for examination, some fossil mammalian remains, which he had brought with him on his return from his second visit to America.[2] They formed part of a collection which had been exhumed in 1838-39, in digging the Brunswick Canal, near Darien in Georgia. A selected series of these remains was presented by Mr. Hamilton Couper, the discoverer, to the Academy of Natural Sciences of Philadelphia, where they were identified by Dr. Harlan, some of whose determinations were corrected by Professor Owen, and those of the latter more recently by Dr. Leidy. The locality and the details of the case have been described, first by Mr. Hamilton Couper,[3] and afterwards from personal observation by Sir Charles Lyell. The specimens brought by the latter included some fragments of the molars of a fossil Elephant, which, after careful examination, I satisfied myself belonged to a species wholly distinct from the prevailing fossil form of North America, namely, *E. primigenius*; my attention having been at the time closely directed to the study of the Proboscidea,

[1] This Memoir appeared in the 'Natural History Review' for January 1863, from which it is here reprinted, with corrections made by the author, and extracts from his Note-books.—[ED.]

[2] 'Second Visit to N. America,' 3rd edit. 1855, vol. i. p. 347.

[3] 'Proceedings Geol. Society,' 1843, vol. iv. p. 33.

fossil and recent. This determination I communicated to Mr. Lyell, who, naturally swayed in his decision by the opinions then prevailing, and his estimate of the turning weight of authority, adopted for the Brunswick Canal form the name of *E. primigenius*, with the comment that the species ranged from the Alatamaha in Georgia, to the polar regions, and thence through Siberia to the South of Europe; while I applied to it, in my notes of a systematic classification of the Proboscidea, the designation of *E. Columbi*, after the great discoverer; purposely avoiding a geographical name, which subsequent research, or more extended materials, might prove to be restrictively vicious.

I was fully impressed with the importance of the result, in proving the co-existence of a distinct species of Elephant with the extinct Edentate Fauna of the Southern States of the Union, and as furnishing a probable explanation of the statements made by Humboldt, Cuvier,[1] Von Meyer,[2] De Blainville, and others, of Elephant remains occurring in Mexico, Texas, and other of the Southern States of North America. Early in the following year I became acquainted with a remarkable series of Elephantine remains, added to the collection of the British Museum, by purchase, in the spring of 1847. They professed to be principally from the vicinity of San Felipe, on the Brazos river in Texas; and I identified a portion of them as being of *E. Columbi*. But I was prevented from following up the subject by my departure to India at the end of 1847, and I reserved it for future research.

Soon after my return to Europe in 1855, Sir Charles Lyell, at my request, placed the Brunswick Canal specimens at my disposal, and I resumed the investigation of the fossil Elephant of the Gulf of Mexico. During the same year I had an opportunity, on the indication of my friend M. Lartet, of examining, in the Palæontological Gallery of the Jardin des Plantes at Paris, a small molar referred to by De Blainville,[3] as having been brought by M. Le Clerc from Texas, which I determined to be a milk molar of the same form. In 1856 I was enabled, through the courtesy of M. Humbert, to examine in the Natural History collection of the Musée Académique of Geneva, a series of molars of the same fossil Elephant, brought from Mexico by M. H. de Saussure, a grandson of the celebrated Swiss explorer of the Alps; and by the kindness of my friends Mr. Charles Norton and Mr. Guild of Boston, I was supplied with an excellent cast of the Alabama molar, figured and described by Dr. Warren.[4] Early

[1] 'Oss. Foss.' 4to edit tom. i. p 157.

[2] Leonhard and Bronn, 'Neues Jahrbuch' 1838, p. 414; *Idem.* 1840, p. 581.

[3] 'Ostéographie: Éléphants,' p. 190.

[4] 'The Mastodon giganteus of North America,' 1855, p. 162.

in the following year (1857) I became cognizant of the most perfectly preserved molar of the same form that I have yet seen. It was discovered in Mexico, and presented to the Museum of the College of Surgeons by Mr. Taylor. This specimen, in conjunction with M. Le Clerc's milk molar, supplied the means of determining the ridge-formula of the entire set of molars, and of fixing the exact serial position of the form among the Elephants.

The whole of these materials I found to be markedly distinct from *E. primigenius*, and to partake of the characters which are typified in the Georgian molars from the Brunswick Canal. But to place the specific distinction from the Mammoth beyond question, I resorted to the crucial test of sawing up the principal molar of the Brunswick Canal series longitudinally and vertically, in the manner figured in the plates devoted to the Elephants, in the 'Fauna Antiqua Sivalensis,' a procedure which commonly quashes at a glance all doubts as to the specific distinctness, or otherwise, of Elephant molars, in critical cases. The section yielded *colliculi*, showing rather thick plates of enamel folded upon cuneiform cores of ivory, of very considerable width at their base, and separated by correspondingly open interspaces filled with thick masses of cement. These characters were strongly in contrast with the attenuated, parallel, and pectiniform disposition of the materials seen in molar-sections of *E. primigenius*; combined with the dilated outline of the 'discs of wear,' and the decided crimping in the plates of enamel, they led me to regard the form as occupying a place in the series between *E. antiquus* and *E. Indicus*, and as differing more from the Mammoth than does the latter from the existing Indian Elephant. These facts were epitomized, but necessarily in a very condensed shape, in the 'Synoptical Table of the Species of Mastodon and Elephant,' appended to the memoir which I communicated to the Geological Society on April 8, 1857.[1] In it, *E.* (*Euclephas*) *antiquus*, and *E.* (*Eueleph.*) *Namadicus*, respectively Nos. 10 and 11 of the list, are included in the group (*f*) characterized by '*Colliculi approximati, medio leviter dilatati, machæridibus undulatis*;' while *E.* (*Eueleph.*) *Columbi* (No. 12), and *E. Indicus* (No. 13), are included in the next group (*g*), characterized by '*Colliculi approximati machæridibus valde undulatis*;' and for the habitat of *E. Columbi* are given Mexico, Georgia, Alabama, with a 'Post-Pliocene (?) age.' Thus, the leading points of the dental characters, and the precise place in the natural series occupied by the species, were distinctly indicated, to-

[1] See p. 14, and Quart. Journ. Geol. Soc., vol. xiii. p. 319. Nov. 1857.—[Ed.]

gether with its range of habitat along a stretch of nearly 20° of longitude in the regions bordering the Gulf of Mexico.

In my second memoir, on the same subject, communicated to the Geological Society on June 17, 1857, I entered into further details on the fossil Elephant of the Gulf of Mexico, adding that it was found in the fossil state along with species of *Mastodon, Mylodon, Megatherium, Equus,* &c.[1] An epitome of the paper, with these statements, is given in Leonhard and Bronn's 'Jahrbuch' for 1858, p. 379; and the name *E. Columbi* is adopted by M. Lartet in his important memoir, '*Sur la dentition des proboscidiens fossiles*,'[2] showing that my determination of the species had not escaped the observation of continental palæontologists.

After the communication of the memoirs above referred to, in which, I believe, the first attempt was made to determine, with precision, the nature of the fossil Elephant of the Gulf of Mexico, I became acquainted with Mr. Bollaert's specimen of an adult lower molar of the same species of fossil Elephant, from the Brazos River in Texas, when it found its way into the British Museum; and the ground having been thus broken, the attention of palæontologists was speedily attracted to the subject.

In September of the following year (1858), Professor Owen, in his address to the British Association at Leeds, while discoursing on the geographical distribution of animals, made these remarks:—'Geology tells us that at least two species of Elephant formerly did derive their subsistence, along with the megatheroid beasts, from that abundant source,' (*i.e.* the luxuriant vegetation of tropical America). 'Nay, more; at least two other kinds of Elephant, *Mastodon Ohioticus* and *Elephas texianus*, existed in the warm and temperate parts of North America.'[2] On this occasion, Professor Owen gives no authority for the name *E. texianus*, although then announced for the first time, thus by the established usage in Zoology, producing it as his own.[3] But in the second edition of 'Palæontology,' published three years later (1861), in referring to the occurrence of the Mammoth in North America, he adds, 'where it existed not only

[1] See p. 211.—[Ed.]

[2] 'Trois autres proboscidiens ont vécu dans l'Amérique du Nord pendant la période post-pliocène ou quaternaire; ce sont l'*Elephas Americanus* que M. Leidy considère comme étant distinct de l'*E. primigenius*; l'*E. Columbi*, Falc., des États du Sud et du Mexique, et le *Mastodon Ohioticus* que quelques auteurs supposent avoir été contemporain des premiers hommes qui se sont établis dans cette region du globe.'—*Bullet. Sociét. Géol. de France*, 1859. 2e Série, tom. xvi. p. 505.

[2] Report Brit. Assoc. Leeds, 1858, Address, p. lxxxiv.

[3] In the Leeds Address, Professor Owen is so scrupulously careful on the score of citation, that he gives in a foot-note the names of the gentlemen to whom we are indebted for having collected the Purbeck Mammalia. (Address, p. lxxxix.)

with the gigantic *Mastodon Ohioticus*, but also with a second species of true Elephant (*Elephas texianus*, Blake), the teeth of which were adapted to a succulent vegetable diet.'[1] In a foot-note to this passage, Bollaert's 'Antiquities of S. America, 2nd edition,' is cited as the authority for the second species. The author of 'Palæontology' omits on both occasions to notice that I had previously determined the Elephant of the shores of the Gulf of Mexico, under a different and recognized specific name; and in defence of the new name, he cites authority the existence of which I have failed to trace. I have ascertained in writing from the publishers (Messrs. Trübner), that no second edition of Mr. Bollaert's work has yet appeared (August 1862); and on consulting the only impression published in 1860, I have been unable to detect the occurrence of the name even of *E. texianus* anywhere throughout the volume, or the name of Blake coupled with any fossil Elephant therein. The sole reference to the Texan Elephant is in a note, professing to be by the author, in which he states that the Elephant-bones occurring in Texas are fossil, and well silicified; adding, 'I have deposited a grinder in the British Museum, which appears to be of a new species, see my Paper on Mastodon Bones in Chile. Geological Soc. Journal, 1857.'[2]

[1] 'Palæontology,' 2nd edit. 8vo. 1861, p. 395.

[2] Bollaert, 'Antiquarian, Ethnolog. and other Researches in New Granada,' &c., 8vo. 1860, p. 80. There is another statement, contained in a foot-note in 'Palæontology,' which demands an observation from me. In the remarks upon *Mastodon Arvernensis* and *Mastodon longirostris*, the following sentence occurs: 'Both belong to that section of *Mastodon* in which the first and second true molars have each four transverse ridges,' (Foot-note: 'First demonstrated by Kaup, "Ossemens Fossiles de Darmstadt, 4to. 1835,") and for which Dr. Falconer proposes the name *Tetralophodon*.' (*Op. cit.* 2nd edit. p. 387.) I challenge the production from the work cited of any passage containing the demonstration asserted in the note; it is certainly nowhere to be found there: even the word *section*, or any other equivalent term, expressive of the idea of a subdivision of the genus into groups does not occur in it, and for the simple reason, that published materials to suggest it did not at the time exist. I was the first to generalize on the subject, and establish the constancy of the *ternary* and *quaternary* ridge-formulæ in the Mastodons as a means of ranging all the known species under the two natural groups of *Trilophodon* and *Tetralophodon*; I further extended the same principle of the ridge-formula to the arrangement of the rest of the Proboscidean forms, or Elephants, under the divisions of *Stegodon*, *Loxodon*, and *Euelephas*. Until then, the species were in extreme confusion; and nowhere was this more signally evinced than in the writings of Professor Owen on the family. Kaup, with characteristic fairness, recognizes the fact in reference to the *Mastodons*. In proof, I refer to his 'Beiträge,' 3 Heft. (1857) pp. 1, 19. What Kaup vehemently claims as his special discovery is, that he was the first to show the precise number of molar teeth, that succeed each other from back to front in *Mastodon* (excluding premolars, *i.e.* vertical successors); and that his observation on that genus furnished the cue for determining the same series in the Elephants. The 'Ossemens Fossiles de Darmstadt' is freely quoted in the 'Odontography,' and in the 'British Fossil Mammalia,' both published ten years later; yet it is not a little singular that the demonstration asserted in the note did not prevent

At length, in November, 1861, Mr. Blake makes his appearance about this fossil Elephant. In a paper, 'On the Distribution of Mastodon in South America,' the following sentence occurs, in sequence to remarks on the remains of *E. primigenius* in North America: 'South of the 30th degree of N. latitude it' (the Mammoth), 'however, gives place to a totally different species of true Elephant (*Elephas Texianus*, Owen, *E. Columbi*, Falconer), the molars of which by their less degree of complexity were more adapted to triturate the soft succulent herbage of Texas and Mexico.'[1] Here it will be observed, the name *E. Texianus* is, with propriety, so far as published evidence goes, attributed to the author, who had four years before become responsible for it. But in February of the present year another paper appeared in the same periodical, entitled, 'On a fossil Elephant from Texas (*E. Texianus*),' by Mr. Blake, who now stands sponsor for that specific designation himself, *E. Columbi* being quoted as a synonym.[2] It is a nice point to decide to whom the credit of the new name should be awarded. Professor Owen at first produces it as his own, and then, after a long interval, assigns it to Mr. Blake: while conversely, the latter, in the first instance, unguardedly attributes it to Professor Owen, and then takes it to himself. There is jactitation of the name between the two naturalists, with hesitation and self-denial on both sides; but it is clear that it is a joint production; and there is a consistent harmony of ideas and expression in their reasoning regarding the succulent food of the fossil species. Indeed, the only difference which I can detect is, that Professor Owen introduces the name with a small initial, and Mr. Blake with a capital; by the canons of nomenclature the younger naturalist has the advantage of

Professor Owen from confounding, under the common designation of *Mastodon angustidens* the dentition of three distinct species of *Mastodon*, one of them belonging to the section *Trilophodon*, and two to the section *Tetralophodon*. Further, in the same work, 'Palæontology,' Sismonda's figure of the Astesan *Mastodon* is reproduced, as the principal illustration of the genus, under the misnomer of *M. Turicensis*, and described as having *ternary-ridged* molars, like *M. Ohioticus*, notwithstanding that Sismonda,* confirmed by myself after a detailed examination, figures and describes it as *quaternary*-ridged: *M. Turicensis* (a synonym of *M. Tapiroides* of the French palæontologists) being a *miocene* species of the Dinotherian type, and the Astesan *Mastodon* (*M. Arvernensis*) a *pliocene* species of another type. These and other like errors, which I could adduce, are brought out in a work professing to be an exposition of the science at the present day. But with reference to the 'Bollaert' and 'Kaup' citations here challenged, it is necessary to direct attention to the reprehensible practice of citing known works for matter, the existence of which cannot be traced in them.

[1] Geologist, 1861. Vol. iv. p. 470.

[2] *Op. cit.* 1862. Vol. v. p. 57.

* 'Osteographia di un Mastodonte Angustidente.' Turin, 1851, 4to. p. 23, line 10. Pl. i. fig. 2.

his senior. But the systematic names of natural objects are not marketable commodities, or negociable instruments of exchange, passable from hand to hand, at the option or caprice of the holders; nor does the usage of science countenance such accommodating arrangements as those above indicated.

Let us now see what intrinsic claims the *Elephas Texianus* of Messrs. Owen and Blake has upon the recognition of palæontologists, Mr. Blake being their exponent:—

'As the British Association, in their rules for Zoological Nomenclature, have authoritatively sanctioned the principle that names not clearly defined, and likely to propagate important errors, may be changed, and as the name of *E. Columbi* lays itself open to the grave charge that it is not clear whether it is named in honour of Columbus, or because it is found in Columbia (Venezuela y Nueva Granada), I trust that this name will not be accepted. That of *E. Texianus*, founded upon a yet unimpeached geographical distinction, if it has not the advantage of published priority, yet gives a more lucid idea of the nature of the species which it indicates.

'The figure by Mr. Mackie gives a better idea of its appearance than any mere verbal description. I however define it as Elephas Texianus, *dentium molarium* (m. 6) *Colliculi undulati, magis remoti quam in E. Indico.* Its association with *E. Indicus* and *Armeniacus*, by Dr Falconer, seems warranted by its legitimate affinities.' (*Op. cit.* p. 58.)

In reply to the first point, the author must permit me to remark that the supposed 'important error' and 'grave charge' are only the results of unripe knowledge and inexperience. The derivation of *E. Columbi* is so obvious, that nothing I can say could make it plainer. No educated naturalist could apply the term to the geographical region of Colombia, without giving it an adjective form, or supplementing the last vowel with an important terminal diphthong, the requirements of the case being inexorable. Putting aside the fact that Colombia was nowhere in question as a habitat of the species, the British Association has not legislated against Latin grammar.

As regards the force of the claim, put forward in the second clause, every terrestrial mammal must have a regional habitat somewhere; but I fail to apprehend how the proposed geographical name would convey 'a more lucid idea of the nature of the species.' In natural history, the distinctive characters of species are commonly founded on something more intrinsic and tangible. Further, four years before, I indicated that the fossil species had ranged from Georgia to

Mexico, a stretch of nearly 20° of longitude. To restrict it to the intermediate region of Texas would be a step of retrograde error.

In the proposed specific definition I fail to detect a single term or character which is not either expressed, embodied, or implied, in my Synoptical Table above referred to; with this difference, however, that the author has mal-adroitly handled terms of which he knew the meaning but imperfectly. The *colliculi*, or constituent ridges of the unworn teeth, are not undulated; but the enamel-plates of these ridges are crimped, and their worn edges in the abraded molar display the character by their '*machœrides undulatœ*.'

On these grounds, I cannot acquiesce in the ingenuously avowed aspiration, that the law of priority should in this case give way, in order that *E. Texianus* of Owen and Blake might supplant the earlier name of *E. Columbi*. The reasons assigned for the proposed change are so light and trivial, that I should not have considered it necessary to notice them, but for the fact that the paper is accompanied by an illustration of the Bollaert Molar; for a figure of a new or imperfectly known form will always carry with it a citation of the name it bears, and of the paper in which it occurs, however slight the latter may be.

§ 2. Dentition of *E. Columbi*.

I shall now examine the principal remains of *E. Columbi* that have come under my observation.

Of the milk-dentition, the only specimen which I have seen is a penultimate milk molar (m.m. 3) *in situ* in a finely preserved left ramus of the lower jaw of a very young Elephant, contained in the Palæontological Gallery of the Jardin des Plantes, and labelled (No. 77), as having been brought by M. Le Clerc from Texas. It attracted the attention of De Blainville (who figured and described it in the dental series of *E. primigenius*) as presenting unusual characters:—

'Le troisième échantillon est plus intéressant, d'abord à cause de son origine puisqu'il vient du Texas d'ou il nous a été rapporté par M. Le Clerc, et ensuite parce qu'il semble indiquer quelque chose de particulier.'[1] In this young molar the anterior ridge, together with the front talon, are broken off, the remaining part of the crown being composed of seven ridges and a slight posterior talon. These ridges are quite intact, and much more apart than in *E. primigenius*, agreeing in this respect with *E. Indicus*. The digitations are well marked at the apex, forming distinct points, and in the last

[1] Ostéographie: Éléphants, p. 190, Pl. x. fig. 2 *c.*

ridge their separation can be traced to a depth of nearly an inch, a condition which ordinarily involves a high degree of crimping of the enamel-plates. The crown is narrow in front, and widens so abruptly behind as to have suggested to De Blainville the term '*subdidyme*' to characterize it; he describes it as resembling most the analogous tooth of the existing African Elephant. This peculiarity is best expressed by the dimensions, viz., length of crown 2·7 inches, width in front at the second ridge 1·1 inch, width behind 1·7; the length being to the extreme width in the ratio of about 3 : 2. The empty alveolus of the last milk molar (m.m. 4) is distinctly visible in M. Le Clerc's specimen. The penultimate milk molar thus yields, for its term in the ridge-formula, 8 colliculi besides talons. The specimen, so far as mineral condition is concerned, is well fossilized, like those from the Sewalik hills and the 'Forest-bed' of the Norfolk coast, being hard, heavy, and weathered, and not adherent to the tongue.

The specimen next to be noticed is a detached and very finely preserved antepenultimate true molar (m. 1) of the lower jaw left side, No. 741 *a* of the additions to the Cat. of Foss. Mamm. of the Royal College of Surgeons. It is a comparatively late acquisition (since 1855), and was brought from Mexico by Mr. Taylor. The crown and body of the tooth are quite perfect from end to end; the fangs are mostly broken off, but a portion of them still remains. The crown is composed of twelve colliculi, with front and hind talons. Of these the eight anterior divisions are worn, the rest being intact. The discs of wear are wide and open, wider than in the ordinary varieties of the existing Indian Elephant, and nearly approaching the width commonly presented by *E. antiquus*. But they differ from those of the latter species in showing no angular expansion in the middle of the discs, and no outlying loop at the angles. In this respect they correspond more with the discs of the existing Indian Elephant. The edges (*machærides*) of the enamel-plates are highly crimped with numerous close set flexures; in this respect also maintaining a resemblance to the Indian Elephant, and differing from *E. antiquus*. Notwithstanding the distinctions here indicated, the aspect of the crown in the Mexican molar bears a striking general resemblance to that of typical specimens of the same age of *E. antiquus*, the most obvious difference being, that the crown in the former is much wider in proportion to the length than in the latter, in which the molars have narrow crowns like those of the African Elephant. The specimen is represented by fig. 2 of Plate X.

A notable peculiarity in the Mexican tooth is, that the body of the molar is very much bowed sidewise, *i.e.* concave on the outer side, and convex on the inner. The amount of arcuation is much greater than I remember to have seen in any other species of Elephant, fossil or recent, in molars of corresponding age, viz., adolescent. Something of the same kind is seen in Mr. Bollaert's specimen, as figured in the 'Geologist;' but in this case, in a minor degree, in consequence of the anterior third of the crown having been worn away. I believe that this peculiarity in the lower molars of *E. Columbi* is a constant character of the species, and that it bears a relation to the converging form of the rami of the jaw, to be noticed in the sequel.

The dimensions of the Mexican molar are:—

Length of crown, 7·4 in. Width of ditto in front, 2·3 in. Greatest ditto, 2·5 in. Height of ditto at eighth ridge, 4·3 in. Space occupied by the eight anterior discs, 4·3 in.

It is hardly necessary to remark that the characters of the molar above described differ entirely from those of the common form of the Mammoth of North America.

Von Meyer, in the 'Neues Jahrbuch' for 1840,[1] briefly notices some fossil remains of Mastodon and Elephant, contained in the Mexican collection of Herr Uhde. Among these are an upper and lower molar of a fossil Elephant, in which the enamel-plates were wider apart than in *E. primigenius*, in this respect having a closer resemblance to those of *E. proboletes* of Fischer de Waldheim, which Lartet conjecturally refers to *E. meridionalis*. The description would agree with that of *E. Columbi*, from the same region.

Sir Charles Lyell's Georgian specimen, from the Brunswick Canal, upon which my first knowledge of *E. Columbi* was founded, consists of the middle portion of the penultimate or last true molar, probably the latter (m. 3), lower jaw, right side, broken off both at the anterior and posterior ends. The fragment comprises ten complete ridges, with part of two others, of which the anterior seven are more or less worn. All the fangs are broken off, together with the basal mass of ivory. The summit of the crown is concave from back to front, and the tooth is also concave with a little torsion on the outside, and convex inwards, showing that it was considerably arcuated laterally, like the specimen last described. The discs of wear are of moderate width, as in the Indian Elephant, with a tendency in some of them to expansion in the middle. This is most pronounced in the second, where the expansion nearly attains half an inch. The plates of

[1] Leonhard and Bronn's 'Jahrbuch,' 1840, p. 581.

enamel are thicker than in the Mammoth, and about equal to those of the Indian Elephant; they present a considerable amount of parallel shallow plaiting, which is prominently shown where they rise above the level of the cement. The wear of the crown takes place in a succession of steps, from the front backwards, which it is of importance to notice with reference to the inferred food of the species. These steps rise like a flight of stairs, each being composed of the whole mass of cement of one of the valleys and the combined enamel-plates and ivory of the ridge immediately behind it. There are five of these steps in the Georgian specimen, the posterior ridges being intact.

The dimensions are as follow:—

Length of crown, measured at the base, 9·5 in. Ditto ditto at summit of crown, 6·9 in. Width of crown in front, 3·2 in. Ditto at fourth remaining ridge, 3·5 in. Ditto behind, at widest part, 3·3 in. Height of ditto, at eighth plate where unworn, 6·2 in. Ditto of anterior worn plate, 2·5 in.

Pl. X. fig. 1, represents a longitudinal section of the specimen, by which the specific distinction from the Mammoth is best shown. The plates converge from the convex base to the summit irregularly, but somewhat like the *voussoirs* of an arch; so that the same number of plates diminishes from 9·5 inches at the base to about 7 at the crown. The ridges are not so high as in the Mammoth, and their constituent elements, *i.e.* the enamel, ivory, and cement, are thicker. In the interval between the 10th and 11th ridges the cement attains, near the base, the excessive thickness of six-tenths of an inch, being about twice as much as what is ordinarily seen in the section of the Mammoth. For the contrasted difference I refer to the sections, Pl. I. fig. 1, of the 'Fauna Antiqua Sivalensis.' (See vol. i. Pl. V. fig. 3.)

The specimen next to be noticed is No. 33,218 of the MSS. register, British Museum, Palæont. Gallery. It was acquired of Mr. Bollaert, and it bears a record of having been procured from San Felipe de Austin, on the Brazos River, in Texas. It is figured in the 'Geologist.'[1] This superb morceau consists of the posterior three-fourths of the last true molar, lower jaw, left side, well advanced in wear. The crown presents the remains of the posterior fourteen ridges and hind talon; the anterior portion had been ground down by use, and has disappeared. The two anterior ridges are worn to the base, and confluent in a common depression of ivory, upon which a slight islet of enamel remains. Of the succeeding ridges, the next seven are worn down into transverse discs, which are open, and bounded by highly crimped and thick plates of enamel, bearing a close resemblance in this

[1] Vol. v. p. 57, Pl. iv.

Fig 1

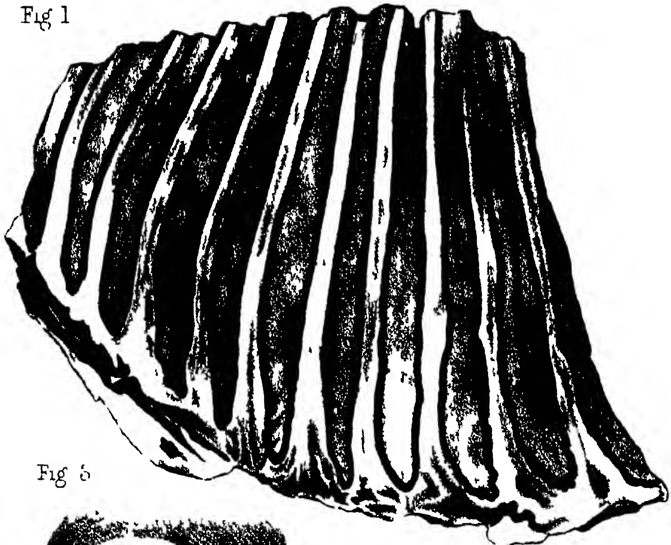


Fig 3

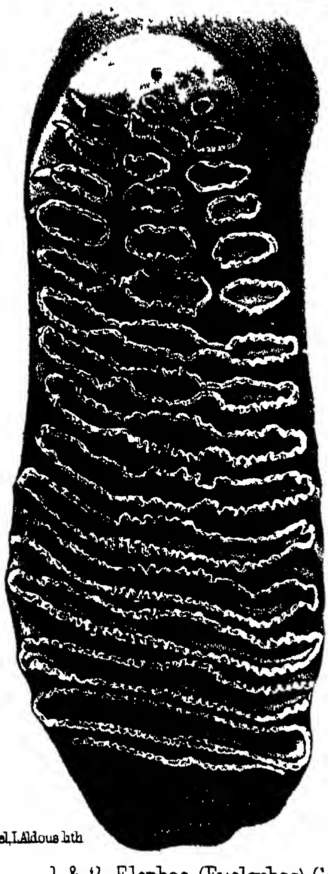
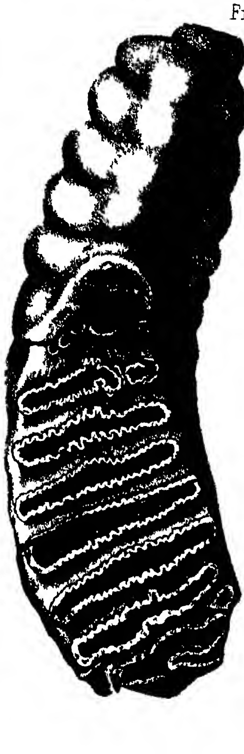


Fig 2



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1 & 2. Elephas (Euelephas) Columbi 3 E. (Euelephas) Armeniacus

respect to the corresponding teeth of the existing Indian Elephant. Some of the plates show a considerable amount of undulation in the general sweep of the *machærides*, but there is no tendency to the mesial expansion, or outlying loop, seen in *E. antiquus*. The five posterior ridges are all more or less affected by wear; the most of them present distinct annular discs on the tips of the digitations, which are seen to be of large size, as in *E. planifrons* and *E. meridionalis*. The eighth ridge shows these annular discs semi-confluent into a transverse depression. The ninth presents five worn digitations; the tenth and eleventh, six; and the twelfth, five. There is no mark of pressure behind, proving the tooth to be the last of the molar series. The space occupied jointly by the first six distinct transverse discs amounts to 5·4 inches, giving an average of nine-tenths of an inch to each ridge. This is considerably greater than that shown by the crown of the Georgian molar, but it is to be borne in mind that the difference is accounted for by the teeth being in different stages of wear.

The principal dimensions are :—

Extreme length of crown, 12·5 in. Width of ditto, at first transverse disc, 3·0 in. Ditto, at fifth ditto, 3·7 in. Ditto, at eighth ditto, 3·8 in. Ditto, at ninth ditto, 3·1 in. Height of crown at ninth ditto where highest, 5·4 in. Space in length occupied by the six anterior distinct discs of wear, 5·1 in.

Making allowance for the part of the tooth borne upon the anterior fangs, which has been worn away, the entire molar must have been of very large size; and it indicates a species that attained colossal dimensions.

Other illustrations of *E. Columbi* are furnished by a collection of fossil bones, part of which was purchased for the British Museum in 1847. They are stated to have been found by Mr. W. Huff on the banks of the Brazos River, near San Felipe de Austin in Texas. One of the specimens, a fine Bovine skull (*Bison latifrons*, Leidy), is identifiable with a figure given by Dr. W. M. Carpenter, of New Orleans, who published the first account of these remains. Among them were numerous fragments of bones, said to have been of Elephant and Mastodon; the teeth of Elephants, especially, predominating. A proboscidean tusk measured eleven feet in length, and twenty-six inches in girth at the base; but no details are given regarding the molars of Elephas.[1] In the series, belonging to the National Collection, reputed to be of this origin (Nos. 20,701–5 MSS. Register) is a superb specimen (No. 20,702) of a last molar of the lower jaw, right side, comprising the posterior three-fourths of the crown in.

[1] Silliman's Journal, 1846, 2nd ser., vol. i. p. 245.

fine preservation, the anterior part having been lost by a vertical fracture. Fifteen ridges are presented together with a talon ridge. Of these, thirteen are more or less worn, the seven anterior into continuous transverse discs, which, measured along the surface of the crown, occupy a length of 4·6 inches. The two next (8th and 9th) are divided towards the outer side by a wide fissure into two unequal flattened elliptical discs; the 10th yields three discs; the 11th, four; and the 12th, five thick annular depressions. The rest are nearly intact, and present from four to five very thick digitations. The enamel-plates of the seven anterior bands present irregular secondary wavy curves, but they are free, or nearly so, from crimping. In this respect, and in being perceptibly thinner, they differ considerably from the other Texan lower molar, No. 33,218 above described. Regarded sidewise, the ridges look very thick and massive, and they are retrofracted about half way up, by an abrupt flexure, somewhat like the Porentrui molar figured by De Blainville (Éléphants, p. 199, Pl. X. fig. 5*a*).

The principal dimensions are:—

Length of space occupied by thirteen worn ridges, 8·5 in. Ditto by seven anterior ditto, 4·6 in. Width of crown in front, 3·1 in. Ditto in middle, 4·6 in. Ditto greatest, 4.8 in. Greatest height of crown, 7·2 in.

The dimensions above yield an average of about ·7 inch to the seven anterior discs, and ·65 to the series of thirteen, being considerably less than in No. 33,218. The latter, also, in the thickness and undulation of the enamel-plates, resembles more the existing Indian Elephant. Although crimping is absent from the fossil under description, the great thickness of the ridges and the limited number and massiveness of the digitations remove it from *E. primigenius*, in which the digitations are slender and double the number. The width of the crown is enormous, being nearly 5 inches, agreeing in this respect with the Alabama molar to be noticed in the sequel. Although with some doubt, I refer the specimen to *E. Columbi.* It is well fossilized and adheres strongly to the tongue.

Another specimen, of the same series (No. 20,702?), is a fragment comprising the posterior two-thirds of a left lower penultimate (m. 2), and including eleven ridges, the talon being wanting. Of these the anterior six are partly worn, but none of them into transverse discs; the first three are in three divisions, each forming a flattened ellipse; the enamel is thick, but does not show any considerable amount of crimping. The ridge-plates are nearly vertical, and the intact digitations of the hinder ones are thick. The crown is well coated with cement.

The following are the dimensions:—

Length of fragment, 7·8 in. Width in front, at middle of plate, 3·4 in. Height where intact at 7th ridge, 5·7 in.

The above dimensions yield an average of ·7 inch to each ridge. The specimen agrees very closely, in every respect, with the corresponding molar of the Indian Elephant, and with the characters of the lower molar, No. 33,218.

There are other Elephant molars in the Texan series, which belong to a different species, to be noticed in the sequel.

The late Dr. Warren, in his excellent monograph on the 'Mastodon of North America,' has figured three specimens, selected by him as representing the principal varieties of fossil Elephant occurring in the United States. One of these, of which I possess a cast (*op. citat.* Pl. XXVIII. A. p. 162) is the Alabama tooth, stated to have been found in the neighbourhood of the Gulf of Mexico. It consists of the middle portion of an enormous last upper molar, right side, well advanced in wear; the anterior part supported on the large front fang had been ground down by use, and the posterior third is wanting. The fragment exhibits eight complete ridges and the half of a ninth in front. Of these, the three anterior are worn into continuous transverse discs, which are open, but without mesial expansion. They bear a close resemblance, in general contour and in the sweep of the secondary curves of the enamel-plates, to those of the Bollaert molar described above, as figured in the 'Geologist.' It is difficult to measure the amount of crimping on these plates from a cast. Dr. Warren describes the enamel-edges as slightly undulating; but his figure represents them to be distinctly and closely festooned as in the molars of the existing Indian Elephant. The fourth ridge has the digital terminations semi-confluent into three distinct discs; the fifth, into four; while the three last ridges are nearly intact. The digitations of the latter are very thick, and do not exceed four or five in number, while commonly, in *E. primigenius*, they are slender and numerous. In illustration of the difference, I may refer to Pl. XXVIII. C. of Dr. Warren's work, representing a huge upper molar of *E. primigenius* from Zanesville, in Ohio, in which the corresponding ridges exhibit the ringed tips of ten slender digitations. The cement filling the valleys is partly removed by decay and denuded on the sides of the crown in the Alabama tooth, so that the character is somewhat disguised; but the discs of wear appear to rise in successive steps as described above of the Darien molar; bearing in mind that the one is an upper and the other a lower molar.

The following are the principal dimensions supplied by the cast:—

Length of the molar measured at base, 7·0 in. Ditto of the 8 posterior ridges at base of crown, 6·6 in. Width of crown at 3rd ridge, 4·6 in. Greatest ditto behind, 4·9 in.[1] Height of the last ridge (intact), 8·0 in.

The above dimensions give an average of eight-tenths of an inch as the thickness of the ridges, a proportion which, I believe, is never attained in the true Mammoth. With the reserve dictated by the defects of a cast, and balancing all the characters, I am led to regard the Alabama molar as being of *E. Columbi*. Dr. Warren appears to have considered it as an extreme variety of *E. primigenius*.

The only other dental remains of this species which I have seen were some mutilated specimens of adult molars in the Musée Académique of Geneva. They were brought from Mexico by M. H. de Saussure. No account of them, so far as I am aware, has as yet been brought out; and the notes which I took were of a general character, without entering into details. They agreed, in all their leading characters, with the Georgian form from the Brunswick Canal in presenting comparatively broad ridges, separated by wider intervals than in the Indian Elephant, but attaining less elevation than in the latter; the enamel-plates were well crimped, and the discs of wear open. They impressed me, at the time, as being distinct alike from the Indian Elephant and from *E. antiquus*, and still more distinct from the Mammoth. The same collection contained the cast of a magnificent specimen of an adult lower jaw of *Mastodon Andium*, invested with a very massive and elongated incisive beak, deflected downwards and retaining the basal section of one very large incisor. The original was stated to have been found near Tlascala, and it appears to be the adult mandible of the same form, which yielded the younger specimen figured and described by Laurillard in d'Orbigny's 'Voyage.'

The materials above described supply only two entire teeth, both being of the lower jaw, *i.e.* a penultimate milk molar (m.m. 3) from Texas, and an antepenultimate true molar (m. 1) from Mexico, the former showing eight ridges, and the latter twelve; but as these two agree in the number of their ridges with the corresponding tooth of the Indian Elephant and Mammoth, and as they exhibit the same series of progressive increments, the complete ridge-formula is inferred to have been thus:—

[1] Dr. Warren states the length to be seven, and the width four and a half inches. The cast may give a line or so of excess, but the crown with its coat of cement must have exceeded 5 inches in width.

Milk molars.				True molars.		
4,	8,	12,	:	12,	16,	20—?
4,	8,	12,		12,	16,	20—?

The last true molars, above and below, commonly present from twenty-two to twenty-four ridges in the Indian Elephant and Mammoth. It remains to be seen, whether, taking into account the greater thickness of these ridges in *E. Columbi*, they ever exceeded twenty in that species.

The species clearly belonged to the group *Euelephas*, and in so far as the dental characters go, its nearest affinity was with the existing Indian Elephant, occupying a position in the series between it and *E. antiquus*. It differs from the latter by the absence of the constant mesial and sub-angular expansion of the discs of wear, common to it in a minor, and to the African Elephant in a major, degree. The difference from the Indian Elephant is less considerable, consisting chiefly in the enamel-plates being less strongly crimped, and in the discs of wear being more open. Judging from the triturating characters of the molars, so far as the analogy of the living species will help us, the food of *E. Columbi* was probably like that of the Indian species, consisting of branches, twigs, and leaves of certain trees, with reedy grasses and other similar vegetable matters. To my apprehension, they do not indicate succulent matters (*i.e.* in the botanical sense of the word) to have been the staple food of the species, as conjectured by Messrs. Owen and Blake, nor anything less ligneous than the aliment of the Indian Elephant. The grounds of this opinion will appear fully in the sequel, in discussing the general bearings of the question with reference to the food of other fossil Elephants.

Of the cranium and other bones of the skeleton, nothing is at present known, although it is probable that abundant remains exist in the North American and Mexican collections. Silliman's 'Journal,' for 1838, contains an account of some elephant bones, discovered in Jackson County, Ohio.[1] Among these was a lower jaw, of which a rude sketch is given, along with that of *E. primigenius*. The rami are represented as converging to a pointed chin and a very contracted symphysial gutter, totally different from the broad rounded chin and wide gutter which are constant in *E. primigenius*. In both respects, the figure agrees more with the mandibular form presented by *E. Indicus* and *E. antiquus*. The bowed Mexican molar, above described, would suggest that the mandible of *E. Columbi* was of a similar form. But the figure

[1] Silliman's American Journ. 1838, vol. xxxiv. p. 347, *et seq.* 'On Mather's Report on the Geological Survey of Ohio.'

of the Elephant of Jackson County is too imperfect to be reliable for more than a conjecture. The figure in the same plate of a detached molar represents a crown resembling that of the Mammoth. The anonymous author of the communication provisionally names the form *E. Jacksoni*, but that this means nothing more than to serve the occasion, is implied by the fact that he names the existing species, compared with it, as *E. recens*, *i.e.* the Indian Elephant.

The 'Huff Collection' from Texas, in the British Museum, includes (No. 20,705) a right ramus of the lower jaw, which presents the outer shell of the bone entire, from the posterior edge of the ascending ramus to the symphysis, but the inner side broken off vertically along the middle of the alveolus (the whole of the inner wall of which is removed, together with the molar contained in it); the beak of the mentum is also broken off. Being so mutilated, it is impossible to say to what species it belonged. But the diastemal edge of the symphysis slopes gently forwards, and with much less vertical abruptness than is characteristic of the mandible of *E. primigenius*. It is therefore not unlikely that the specimen belongs to *E. Columbi*.

Apart from the very numerous instances, recorded in the American Journals, of the occurrence of Elephant remains in most of the United States, and commonly attributed to the Mammoth, there are two cases bearing upon *E. Columbi* which require special notice.

The first from the same reputed Texan series, in the National Collection, is an enormous fragment of a cranium, composed of the right maxillary, part of the malar, and the right half of the palate, and containing a stupendous last true molar (m. 3) *in situ*, in fine preservation. The posterior half of the alveolus is wanting, leaving a great part of the tooth exposed. The anterior part of the crown, borne on the large front fang, had been ground away, but its presence is distinctly indicated by the fang-pit of the inner division, in front of the tooth. What remains of it is composed of twenty ridge-plates, with a single talon-digitation appended behind. The anterior fourteen or fifteen are more or less worn, the hinder ones being intact. The general plane of the worn surface is quite flat, as is usual in Mammoth molars, and is free from any tendency to the terraced steps seen on the crown of *E. Columbi*. The discs of wear form narrow closely compressed bands, transverse and straight, with no mesial expansion. The enamel-plates are thin, and as a general rule unplaited, although some of them, as in the fifth ridge, exhibit a certain amount of fine crimping. The enamel-

edges (*machærides*) rise but very little in relief above the ivory and cement. The ridge-plates are vertical and enormously high, the fourteenth, which in the germ was not the highest, measuring between 10·5 and 11 inches. The five hinder plates fall off very rapidly in height. The crown is very broad, being but a line or two short of five inches.

The following are the principal dimensions :—

Length of crown measured by a tape, over the summit from base of talon to anterior fang-pit, 18·25 in. Ditto from hind talon to anterior fang, straight by callipers, 14·2 in. Width of crown in front, 3·4 in. Ditto at middle of ninth ridge, 5·0 in. Ditto behind, 3·5 in. Height of fourteenth ridge, 10·7 in.

The ridges are so condensed that the joint length of the posterior twelve, having worn discs, amounts only to 6·7 inches, being an average of about half an inch to each. The Alabama tooth and this Texan molar agree in being of very large size; but they differ throughout in the detail of distinctive characters. I can detect nothing by which the latter can be distinguished from *E. primigenius*. It is of a colossal size. The substance of the bone and tooth is like iron-shot, and the matrix is a coarse ferruginous gritty sand, mixed with fine gravel.

The second case is more remarkable and important, being that of the fossil Elephant of the Pliocene Fauna of Niobrara, an affluent of the Missouri River in Nebraska, the account of which, by Dr. Leidy, has excited much interest and surprise among palæontologists.[1] According to that distinguished naturalist, this extinct Fauna has already yielded 3 distinct *Canidæ*; 3 distinct *Felidæ*; 2 *Rodents*; 8 *Ruminants*, the majority of them new; 8 *Equidæ*, belonging to six genera or sub-genera; 1 large Rhinoceros (*R. crassus*, Leid.) 'which appears to have had almost the same size and formula of dentition as the recent Indian Rhinoceros, *R. Indicus*'; 1 Mastodon of the sub-genus *Tetralophodon, M. mirificus*, Leidy, and a huge Elephant, *E.* (*Eueleph.*) *imperator*, Leidy. The published descriptive details of this Elephant are as yet but very meagre. One specimen only is mentioned, being the anterior portion of an upper molar, of larger dimensions than any known to the author. The crown is stated to be 'within a line or two of five inches in breadth, and within a space of seven inches only eight enamel-folds or double plates exist.' This would give an average of nearly nine-tenths of an inch to each ridge, corresponding closely with the proportions yielded by *E. Columbi*. The ridges are described as becoming worn into transverse strongly crenulated ellipses. Dr. Leidy adds, 'that the fragment of the tooth has been

[1] Proceed. Acad. Nat. Scien. Philadelph. 1858, p. 20, *et seq.*

assumed to belong to an unnamed species, from the fact that it was found in association with a fauna very distinct from any previously noticed.'[1]

§ 3. Range of Habitat and Geological Position of *E. Columbi.*

The precise localities where remains of the species occur in Mexico, and the conditions under which they are met with, are but imperfectly known. The best authenticated site is the 'Barranca of Regla' near Real del Monte, 60 miles north of the city of Mexico. It is stated in Silliman's 'Journal,' that in that region they are found in some places in beds overlaid by lava.[2] The fragments of Elephant molars communicated by Humboldt to Cuvier are said to have been found at Hue-huetoca, in the valley, and not far from the city of Mexico.[3] Cuvier describes the remains from Hue-huetoca, as detached plates of very large molars, compressed, and with the enamel attenuated and barely crimped, as in the Siberian Mammoth. Von Meyer states, that the remains brought to Europe by Herr Uhde were met with, partly in the valley of Toluca, near the Hacienda of Salceda, about 9,000 feet above the level of the sea, partly near the ancient pyramid of Wilcox (*sic*), on the Chalco-Lake, at 7,500 feet above the sea, and some others on the hills of Chapultepec, about 100 feet above the level of Mexico.[4] M. H. Saussure, in a communication, with which he has very courteously favoured me, mentions that the remains of the fossil Elephant which he brought from Mexico were met with in the deposits of Puebla and on the slopes of Tacubaya, in the valley of Mexico (*antea*, p. 213); and that the Mastodon remains occurred, some of them near Xalapa, others at Atonilco el grande, near Real del Monte, and the great mandible with the elongated beak (*antea*, p. 226) near Tlascala. In reference to the stratigraphical nature of the deposits, he adds: 'Je crois que tous les terrains du plateau, composés d'argiles et de cinerites contiennent les mêmes espèces. Ce sont des amas de déjections volcaniques melées par les eaux qui ont rempli les bas-fonds. Ils ont une puissance de plus de 100 pieds.' The remains which have been observed in Texas were discovered on the banks of the Brazos and Colorado Rivers, at San Felipe, Bastrop, &c., in the prairie deposits.[5] Cases of the occurrence of Elephant remains in the valley of the Missis-

[1] *Idem*, p. 29.

[2] Silliman's American Journ. of Scien. 2nd ser. 1858, p. 283.

[3] Cuvier. Oss. Foss. 4to. tom. i. p. 157.

[4] Leonhard and Bronn's 'Jahrbuch,' 1840, p. 581.

[5] Bollaert Journ. R. Geograph. Soc. vol. xx. 1850, pp. 115-117.

sippi, in the States of Louisiana, Arkansas, and Mississippi, have been recorded, but not in sufficient detail to determine the species. Dr. Warren mentions that he possessed thirty molars of the fossil Elephant of Alabama, but he gives no details regarding the conditions under which they were found.[1] All the circumstances connected with the remains occurring in Georgia have been carefully investigated by able observers. Between the Apalachian Mountains and the Atlantic there is a wide stretch of horizontal tertiary strata, forming three terraces, each about twenty miles wide.[2] The lowermost, or littoral, platform rises from ten to forty feet above the level of the sea, and stretches at least 400 miles northward to Newbern on the Neuse in Carolina. The deposit is fluvio-marine, resting upon Eocene strata; although mainly marine, it contains beds of freshwater origin, in which the Mammalian remains occur. Lyell considers it to be very analogous to the great Pampean formation of South America, as described by Darwin, and to be of Pleistocene age. The bones were found between four and six feet below the surface, embedded in clay and resting on yellow sand, and belonged to *Megatherium*, *Mastodon*, *Elephant*, *&c*. The ascertained range of *E. Columbi*, from Mexico to Georgia, includes 18° of Long. and 12° of Lat. between the parallels of 20° and 32°. But there are grounds for suspecting that it ranged into South America. M. Lartet has recorded the fragment of an Elephant's molar, characterized by thick ridge-plates, brought from Cayenne in French Guiana by Captain Perret, and presented by him to the Museum of Marseilles.[3] What makes this not improbable is the fact, that Dr. le Conte while in Honduras examined the Mastodon bed near the village of Tambla, in one of the passes leading from the plain of Comayagua to the Pacific, and satisfied himself that the species found there was identical with *M. giganteus* (*Ohioticus*) of North America.[4] It is therefore not unlikely, that the fossil Elephant of Georgia may have ranged still further south than Mexico, into Guiana.

§ 4. Associated Fossil Mammalia.

Of the Mexican Mammal contemporaries of *E. Columbi* but very little has as yet been ascertained. Von Meyer, in his notice of Herr Uhde's collection, mentions a Mastodon resembling *M. angustidens* of Kœpfnach in Switzerland; a

[1] On Mastodon giganteus, p. 62.

[2] Hamilton Couper. Geol. Proceeds. 1843, vol. iv. p. 33, and Lyell's Second Visit to North America, 3rd edit. 1855. Vol. i. p. 347.

[3] Bullet. Soc. Géol. de France, 2d sér. tom. xvi. p. 500.

[4] Proceed. Acad. Nat. Scien. of Philad. 1858, p 7.

phalangeal bone of a Pachyderm, bearing some resemblance to that of the genus *Rhinoceros*; and upper and lower molars presenting the characters of the existing genus *Equus*.[1] The collection formed by M. H. de Saussure included *Mastodon Andium*, as distinguished by the French palæontologists from *M. Humboldtii*. In Texas,[2] as already stated, *E. Columbi* was found along with remains of *Tapirus Americanus* (Leidy), *Bison latifrons* (Leidy), a species of *Mastodon* not named; bones supposed to be of a species of *Mylodon*, and probably also a colossal form of *E. primigenius*.

The Georgian remains from the Brunswick Canal have been severely examined by different palæontologists. Among them, besides Elephant, there were *Megatherium mirabile* (Leidy), *Mylodon Harlani* (Ow.), *Mastodon Ohioticus*, *Bison latifrons* (Leidy), *Equus Americanus* (Leidy),[3] together with bones of a large Chelonian, *Chelonia Couperi* (Harlan). It was supposed, at the time of their discovery, that the Darien fossil Fauna included *Hippopotamus* and *Sus*;[4] of these the former was negatived by Prof. Owen, and the tusk fragment upon which it was founded referred to Mastodon, while the latter has passed through many phases of nomenclature. First named *Sus Americana* by Harlan (*loc. cit.*), it was then regarded by Prof. Owen as the type of a new genus intermediate to *Lophiodon* and *Toxodon*, which he first described under the designation of *Lophiodon bathygnathus*,[5] and afterwards as *Harlanus Americanus*;[6] but the specimen upon which the opinion rested has been satisfactorily determined by Leidy to be nothing more than a lower jaw of his *Bison latifrons*.[7] At Skiddaway Island on the Atlantic shore, near Savannah, the same genera and species have been met with; and Dr. Leidy mentions the association, on the shores of the Ashley River in South Carolina,[8] of remains of the same *Megatherium*, with those of *Elephas*, *Mastodon*, *Equus*, *Tapirus*, *Dicotyles*, *Hipparion Hydrochærus*, &c.[9] On all occasions, until lately, where this Elephant has been named in the American memoirs, it has been cited as *E. primigenius*. Generalizing approximatively, as far as the ascertained data will admit, it would appear that where fossil Elephants occur in the States east of the Mississippi, those found to the north of the Apalachians belong chiefly to *E. primigenius*; and

[1] Leonhard and Bronn's 'Jahrbuch,' 1840, p. 581.

[2] W. B. Carpenter. Silliman's Journal, 1846. 2nd ser. vol i. p. 245.

[3] Leidy. Extinct Sloth Tribe of North America, 1855, p. 54.

[4] Harlan in Silliman's Journal, vol. xliii. 1842, p. 143.

[5] Cat. Foss. Mammal. &c. Mus. Coll. of Surg. p. 197.

[6] Proceed. Acad. Nat. Scien. Philadelph. vol. iii. 1846, p. 94.

[7] Proceed. Acad. Nat. Scien. Philad. 1854, vii. p. 89.

[8] 'Extinct Sloth Tribe, &c.' p. 51.

[9] Leidy, *op. cit.* p. 58.

that *E. Columbi* is the predominant although not the sole species, in the littoral States south of the chain, as far north as Newbern, near Cape Hattras. Huge extinct Edentata accompany both ; but Dr. Leidy has found no authentic evidence of *Megatherium* having ranged beyond the maritime portion of Georgia and South Carolina. *Mylodon Harlani* is said to occur north and south of the chain.

Knowing, as we do, what an important feature the large extinct Edentata constitute in the Newer Pliocene Fauna of the littoral regions both of North and South America and of the interior of the United States, it is not a little remarkable that neither in the Lower Miocene Fauna of Nebraska, nor in the Pliocene Fauna of Niobrara, both of which have been so ably investigated by Leidy, has a single Edentate form been discovered, although in the latter, as already mentioned, both an Elephant and Mastodon occur.[1] The great number of Equine forms found in the Niobrara deposit, coupled with the antiquity of some of the genera to which they have been referred (*e.g. Anchiterium*), is equally remarkable, and suggestive of reflexion with reference to some of the great problems which now occupy naturalists, regarding the derivation and spread of species and the former continuity of continents which are now severed by wide oceans.

Of two asserted facts, which it was of the utmost importance to determine with accuracy, one appears to have been clearly established: namely, that the extinct Edentate and Proboscidean Fauna of the United States existed long after the deposition of the Northern Drift. This was put beyond doubt by Lyell many years ago; the bones of *Mastodon Ohioticus*, which are commonly associated with *E. primigenius*, were found along with existing shells in Tennessee in a swamp 'in a cavity of the boulder-formation, so that the animal must have sunk after the period of the Drift, when a shallow pond fed by springs was inhabited by the same species of freshwater mollusca as now live on the spot.' The same result was arrived at in the freshwater deposit on the right bank of the Niagara, near the Falls. The Drift between Lakes Erie and Ontario was inferred to be of much higher antiquity than the gravel containing the bones of Mastodon at the Falls.[2]

But the evidence in support of the inference that the same extinct Fauna existed before the deposition of the 'Drift,' in the same region, is not equally conclusive. It has been

[1] Proceed. Acad. Nat. Scien. Philad. 1858, p. 20, *et seq.*

[2] Proceed. Geol. Soc. 1843, vol. iv. p. 36. These results have been confirmed by the later observations of Professor Ramsay. Quartly. Journ. Geol. Soc. 1859, vol. xv. p. 214.

asserted that Dr. W. M. Dickeson discovered in Mississippi, east of Natchez, remains of *Megalonyx*, *Mylodon*, *Mastodon*, *Equus Americanus* (Leidy), *Bootherium*, *Cervus*, *Ursus*, *Tapirus*, &c. 'in a tenacious blue clay which underlies the diluvial Drift.'[1] The precise determination of the geological age of the deposit in this instance is of the very highest importance, since, at a depth of about two feet below the skeletons of *Megalonyx* and other extinct genera, it yielded, according to Dr. Dickeson, the greater part of an *os innominatum*, which was identified as being of an adolescent human subject, and which proved to be strictly in the same fossil state, as regards colour, density, and mineral condition, as the bones of *Megalonyx* and the other associated animals. Had both the asserted facts been satisfactorily established, the antiquity of the human race would have been carried back in America to a period infinitely more remote, than has anywhere as yet been claimed for it through recent investigations in Europe. But the term '*diluvial drift*' appears to have been used, in this instance, in the vague comprehensive sense in which it was generally applied by geologists, before the labours of Prestwich, Godwin-Austen, and other observers had discriminated the relations of the true 'glacial drift' from those of the Valley Gravels and Loess deposits. I am informed by Sir Charles Lyell, that the bed of material overlying the 'blue clay' at Natchez is of the nature of a Loess or Lehm deposit, and that the clay itself is probably of a more modern date than the 'true drift.' A shade of suspicion has been cast on the identification of the fossil itself, as having been derived from a human subject, by a remark made by Dr. Leidy, who has examined and identified the associated remains.[2] Other instances have been appealed to in proof of the Proboscidean and Edentate Fauna having preceded the 'drift' in the United States; but in no case as yet, has the evidence been as conclusive, as it can be shown to be with regard to the Mammoth in Europe.

§ 5. Synonymy of American Fossil Elephants.

The Elephant molars, occurring so abundantly along with *Mastodon Ohioticus* in the United States have, since the time of Cuvier, been almost universally referred to *E. primigenius*.

[1] Proceed. Acad. Nat. Scien. Philadelph. 1846, vol. iii. p. 107, and Leidy, *op. cit.* p 6.

[2] 'With these specimens, and presenting the same general appearance of colour, compactness, &c., was discovered the *so-called* fossil human innominate bone.' (Leidy, 'Extinct Sloth Tribe,' p. 6.) The authenticity of the specimen and of the identification is strongly maintained in Morton's 'Types of Mankind,' by Nott and Gliddon, p. 343. Sir Charles Lyell no longer doubts the authenticity of the bone as contemporaneous with the associated remains.

But an impression existed among palæontologists in America that there might be distinct species. Dr. Warren, in 1855, expresses it thus: 'We still remain without any decisive fact calculated to determine whether the American varieties differ specifically from the European, and whether these varieties differ specifically from each other.'[1] In 1852, Leidy, in the introduction to the 'Fossil Fauna of Nebraska,'[2] designates the fossil Elephant of North America *E. Americanus*, as distinct from *E. primigenius*. But he gives no diagnostic characters, and assigns no reason for the change, which appears to be founded mainly on the supposed improbability of the same species having ranged from Europe to America. His *E. imperator* he assumes to be distinct, 'because it was found in association with a Fauna very distinct from any previously noticed' (*antea*, p. 230). He separates the *Megatherium* of North from that of South America, avowedly on these grounds; and it would appear that he distinguishes his *Equus fraternus* and *E. complicatus* from the European forms called *E. primigenius* (*sic*) [3] and *E. plicidens*, on the same principle.[4] But the practice is open to grave objections. It assumes a difference on theoretical grounds, where the direct evidence, so far as it goes, indicates the contrary; and its general adoption would tend to arrest, on the threshold, the investigation of the means through which remote geographical forms, presenting common characters, may have started from a common origin.

The separation of some of the American Pleistocene Horses and Bisons from the European fossil species may prove, on the comparison of sufficient materials, to be well-founded. But as regards the true Mammoth, *E. primigenius*, exclusive of *E. Columbi*, I am satisfied that it rests on no sufficient grounds. The well-known characters, upon which Cuvier established his definition of the species, have been confirmed by the general observation of palæontologists up to the present day, namely: the cranium long, with a concave forehead, and very elongated tusk-sheaths; the lower jaw rounded, with a rudimentary beak; the molar teeth very broad relatively to their length, and the constituent layers of ivory, enamel, and cement very thin and condensed. The definition was good, in consequence of its including so many

[1] On 'Mastodon Giganteus,' p. 161. Agassiz, at the Cambridge (U. S.) meeting of the American Assoc. for the Advancement of Science, 1849, described the molar and tusk of an Elephant, found at Vermont in digging the Rutland and Burlington Railway, and said to have been from below the Erratic boulder drift, which *from recollection* he believed to be different from the European Mammoth (p. 100).

[2] *Op. cit.* p. 9.

[3] *E. fossilis.*

[4] Proceed. Acad. Nat. Scien. of Philadelphia, 1858, p. 11.

elements of undoubted authenticity, presented together in the same individuals. But entire skulls are very rare, and it is only under favourable circumstances that entire mandibles are met with; while the dense, hard, and more durable molars occur everywhere. Practically, therefore, the identification of the species, in most instances, rests upon them: and the characters which they yield are so constant and well marked, that, with care on the part of the observer, they are perfectly reliable and sufficient for the purpose. In the London collections, taking those of the British Museum and College of Surgeons together, abundant materials exist for the comparison of molars of the American Mammoth with those of the Siberian and European forms. The Hunterian collection contains a fine series of palates with teeth, lower jaws, and detached molars of the Mammoth, from different localities in the United States. The vast collection in the British Museum includes numerous remains of the species from Eschscholtz Bay and Siberia, accessible for ready comparison with British specimens. They all present, in the main, the same characters: a uniform ridge-formula; the same obtuse form of the lower jaw, and the same broad-crowned molars, composed of closely compressed colliculi, with numerous digitations and attenuated uncrimped enamel-plates. The space within which the present communication is necessarily limited prohibits my entering into the details of the comparison. One of the most essential points is to determine the constancy of the ridge-formula, which, after the examination of a very large quantity of materials, I believe in the Mammoth to be thus:

$$\overbrace{\frac{4,\ \ 8,\ \ 12}{4,\ \ 8,\ \ 12}}^{\text{Milk molars.}} : \overbrace{\frac{12,\ \ 16,\ \ 24}{12,\ \ 16,\ \ 24}}^{\text{True molars.}}$$

the consecutive ciphers indicating above and below, the number of colliculi which normally enter into the composition of the antepenultimate, penultimate, and last milk molars in the first groups, and in the second, those of the three true molars. The plates advance by quaternary increments in each series, bearing in mind that the first true molar, although of larger dimensions, commonly repeats the number of ridges presented by the last milk molar, and that the last true molar in all the Elephants and Mastodons is more composite than the others.[1]

[1] I take this opportunity of indicating a correction in the 'ridge-formula' of the subgeneric group *Euelephas*, given in my memoir 'On the Species of Mastodon and Elephant,' contained in vol. xiii. of the Quarterly Journal of the Geol. Society, 1857, p. 315. Instead of the ciphers

$$\overbrace{\frac{4,\ 8,\ 12,}{4,\ 8,\ 12,}}^{\text{Milk molars.}} : \overbrace{\frac{14,\ 18,\ 24,}{14,\ 18,\ 24\text{–}27,}}^{\text{True molars.}}$$

The formula in the North American Mammoth is identical with that of the Siberian and European forms. Exceptions are occasionally met in which an unusual number of plates is presented. For instance, Dr. Warren figures and describes a last upper molar from Ohio, in which, including talons, the tooth presents thirty-two ridges.[1] But *Mastodon Ohioticus*, in which the dental characters are very constant, occasionally exhibits a similar numerical excess in the ridges in the last true molar.[2]

There is one peculiarity, however, in the molars of the North American Mammoth which is so constant, that, I believe in most instances, by means of it, they can be discriminated in a mixed collection of European, Asiatic, and American specimens, namely, that the ridges and their constituent elements are more attenuated and condensed. For example, in the Museum of the College of Surgeons there is a palate-specimen (No. 620 of Cat.) containing the antepenultimate true molar, on either side perfect but well worn. On the left side the tooth measures 5 inches long by 2·7 in. wide, and presents the discs of 14 ridges, inclusive of the two talons, being an average of but ·36 inches to each. A superb specimen of a last upper, in the Hunterian collection from Ohio, presented by Dr. Casper Winter (No. 615 Cat.), exhibits 17 discs of wear in a length of 7·7 inches, giving an average of ·46 to each ridge; while a last upper molar from Siberia, presented by Dr. Rogerson, gives an average of ·54 for each ridge. Taken singly, the difference seems inconsiderable, but when uniformly repeated over a length of crown comprising sixteen or twenty-four ridges, it is perceptible at a glance, and gives a certain amount of distinctive physiognomy to the molars of the North American Mammoth. The same character is seen in specimens from Eschscholtz Bay, *e.g.* in a palate (No. 24,585) Palæont. Gallery, British Museum. But I do not regard it as indicating more than a slight geographical variety, for the other characters, such as the form of the lower jaw, &c., remain constant to the true Mammoth type.

It has been asserted that the kind of molar upon which *E. meridionalis* is founded occurs not only in England, but as far north as Eschscholtz Bay in Arctic America; and the figures given by Buckland, in the voyage of the 'Blossom,'

the series should have been:

$$\overbrace{\frac{4,\ 8,\ 12,}{4,\ 8,\ 12,}}^{\text{Milk molars.}}\quad \overbrace{\frac{12,\ 16,\ 24,}{12,\ 16,\ 24\text{–}27.}}^{\text{True molars.}}$$

The correction, it will be observed, applies solely to the ciphers above and below, characteristic of the *antepenultimate* and *penultimate* true molars, the discrimination of which always presents the greatest difficulties.

[1] On 'Mastodon giganteus,' p. 163, Pl. xxviii. fig. *c*.

[2] On 'Mastodon giganteus,' p. 79.

are cited in illustration.[1] But the assertion has arisen from a hasty and superficial examination of the specimens. The ivory-cores of the ridges in the Elephants are wedge-shaped bodies, broader at the base and thinning upwards. The plane of abrasion intersects these wedges obliquely, so that, when far advanced in wear, the discs of the same ridges are much wider below than the width of their base, and than they were in the earlier stage at the apex. The Eschscholtz Bay molar referred to is a last true molar, so far advanced in wear that little more than the posterior half of it remains in the lower jaw. In front, part is worn down to the base, thus yielding the dilated appearance which has been mistaken for the character of *E. meridionalis*. The mandible which contains it is preserved in the British Museum, exhibiting all the typical characters of *E. primigenius*. When the materials are in a tolerably fair state of preservation I have hardly ever seen a case where a molar of *E. meridionalis*, or of *E. antiquus*, could be confounded with that of the Mammoth. Mutilated and fragmentary specimens are frequently puzzling; simply because they are *torsos* of the worst description, in which parts are not merely wanting, but what remains is disfigured and disguised by abrasion.

In the view here taken there are, at the present time, but two well determined species of fossil Elephant known in North America.

1. *E. primigenius*, Blumb. Syn. *E. Americanus*, Leidy. The name *E. Rupertianus*,[2] of Sir John Richardson, might have been cited as another synonym, but for the fact that that distinguished naturalist and Arctic explorer, with characteristic firmness, withdrew it, as soon as he became aware, by his own later researches, that it was untenable.

2. *E. Columbi*, 1857, Syn. *E. primigenius, pro parte*, of the American palæontologists; *E. Texianus*, Owen, 1858.

Whether the Cayenne specimen spoken of by Lartet (*antea*, p. 231) belongs to this, or to a distinct species, remains to be ascertained.

The same, with our present knowledge, must be said of the *E. imperator* of Leidy, from Niobrara. Until a perfect molar is figured and described, no satisfactory opinion can be formed as to what the species is. Dr. Leidy, as already stated, assumed it to be distinct, and gave it the name upon the assumption.

The same uncertainty applies to the specimens described conventionally by the anonymous author, for the occasion,

[1] British Foss. Mamm. p. 238 (see *antea*, p. 107, note).—[Ed.]
[2] Zoology of the Voyage of the 'Herald,' p. 102.

under the name of *E. Jacksoni* (*antea*, p. 228).[1] The detached molar, by the figure, agrees with *E. primigenius*, while the lower jaw, so far as the figure can be trusted, indicates a different species.

§ 6. Range in Time of the Mammoth.

The geographical range of the species has been established from Texas across the continent of North America to Eschscholtz Bay, thence from Arctic Siberia, across the steppes of Russia, through Germany, France, and England, to Central Italy in the neighbourhood of Rome. I carefully examined the collections at Naples, including that of the University, where every facility was afforded to me by Professor Scacchi, and that of Signor Costa, but failed to detect a trace of it there, or in Sicily, in the Museums of Syracuse, Catania, Messina, or Palermo, the last of which contains a very considerable number of molars and other remains of fossil Elephants. There is clear evidence of the true Mammoth having existed in America long after the period of the Northern Drift, when the surface of the country had settled down into its present form. It becomes a question of the highest interest and importance to ascertain the first appearance of the species in time. The data for its solution are still so limited and imperfect, that the most we can do is to indicate where it is earliest met with, as a starting point

[1] Almost the last scientific work in which Dr. Falconer was engaged, before his fatal illness, was the commencement of a paper, entitled 'On the so-called *Elephas Jacksoni* of North America.' Fresh interest, he said, had been infused into the discussion by a paper, 'On the remains of fossil Elephant found in Canada by Mr. E. Billings, F.G.S., the able palæontologist of the Canadian Geological Survey. Mr. Billings had figured and described some well preserved remains of the lower jaw, one of them including an entire molar, found at the bottom of a gravel section forty feet deep at Burlington Heights, near the western extremity of Lake Ontario, and at an elevation of about 60 feet above the lake. Although the dental characters resembled those of the Mammoth, Mr. Billings found the form of the symphysis so different, that he was led to regard the Canadian form as a distinct species, and proposed to resuscitate for it 'the obscure and hardly ever recognized name of *E. Jacksoni*, provisionally and anonymously applied to certain Ohio specimens discovered by Briggs and Foster in 1838.' The evidence adduced by Mr. Billings failing to convince Dr. Falconer that the Ontario remains differed in any material respect from the Mammoth, he applied to Sir William Logan, and forthwith obtained a cast of the principal specimen, in order that it might be compared with a sufficient number of typical specimens of the European Mammoth. The details of this critical comparison Dr. Falconer unfortunately never lived to tell, but the result was a confirmation of his original opinion, that the so-called *E. Jacksoni* was not a distinct species. As Dr. F. observed, the question involved interests of much higher importance than the mere settlement of a disputed species, viz.: whether an extinct European Elephant of the Quaternary period, whose remains had been found as far south as central Italy, really ranged from Arctic Siberia across Behring's Strait into Arctic America, and thence across Rupert's Land to the valley of the St. Lawrence and the adjoining lake regions; and if so, under what physical conditions this migration had taken place? This question is considered further on (see p. 245).—[Ed.]

for future observation. That the Mammoth existed in Europe long after its emergence from under the sea of the Northern Drift has been clearly established by more than one class of evidence. Abundant remains of the species have been observed in the 'high' and 'low level gravels' of river valleys in France and England, the nature and origin of which have been so ably investigated by Prestwich and other observers; these valleys having been excavated either during or after the rise of the drift-covered land, but mainly after it, when the country was inhabited by the Mammoth, *Rhinoceros tichorhinus*, &c., during the decline of the Glacial period. In the Apennine valley of the Chiana in Tuscany, *E. primigenius* existed so late as to have been a cotemporary of the Irish Elk (*Cervus euryceros*), *Bos primigenius*, and *Bison priscus*, bringing down the period to the very modern date of the superficial marly beds of the Isle of Man. The proofs of this assertion will be given more in detail in the sequel. Setting aside the cave evidence, on which I have dilated elsewhere, there is a specimen of a last lower molar, left side, of a Mammoth, in the Natural History Museum of Torquay, presented by Mr. C. E. Parker, which, Mr. Pengelly informed me, was dredged up in Torbay, at no great distance from the shore, and probably came out of the well-known submerged 'peat' or 'forest-bed' of that inlet. It is exceedingly fresh-looking, with a slight tinge of smut, as if it had lain in a peat-bed, and the surface is entirely free from any incrustation of marine Polyzoa, with which it must have got covered, had it lain long at the bottom of the sea. This peat-bed indicates a subsidence of the land in Devonshire, then peopled with Elephants, of a very modern date, and long subsequent to the period of the raised beach, which is so boldly developed along that part of the coast.

For a long time I was led to question the occurrence of the true Mammoth in England, anterior to the deposition of the 'Boulder Clay,' in consequence of the questionable nature of the evidence upon which the asserted instances rested. They had either not been observed *in situ*, or were patched over with recent Polyzoa, showing that they had been dredged up from the bottom of the sea. But I have lately seen abundant proof of indisputable authenticity in the collections of the Rev. John Gunn, of Irstead, and the Rev. S. W. King, of Saxlingham, both in Norfolk, besides other cases, that *E. primigenius* of the characteristic type existed in England before the deposition of the Boulder-Clay. Perfect molars, presenting every element for rigorous identification, have been found in the 'Forest-bed' at the bottom of the section, between Cromer and Happisburgh,[1] on a horizon of fluviatile or

[1] See *antea*, p. 164.—[Ed.]

lacustrine strata, which have yielded remains of *E. meridionalis*, *E. antiquus*, *Rhinoceros Etruscus*, and *Hippopotamus major*, &c. But not a trace of Mammoth has as yet been discovered in the 'Norwich' or in the 'Suffolk crag.' The submergence of the land of the 'Forest-bed' under the sea is defined with the utmost precision; the true Mammoth existed in England long before it, or at any rate during the gradual refrigeration which preceded that event.

In the supplement to Sir Charles Lyell's 5th edition of the Manual of Geology (1857), it was stated on my authority 'that there is no well authenticated example of this species (*E. primigenius*) having ever been met with south of the Alps. The specimens from Monte Mario and other localities near Rome belong, according to him (Dr. F.) to *E. antiquus*, Falc., and *E. meridionalis*, Nesti, and those in Piedmont and Lombardy to the same two species, together with *Elephas priscus*.' But this opinion was negatived in 1858, by the fact that M. Lartet, whose verdict is of the highest authority in all that relates to the Proboscidea, identified an unquestionable specimen of *E. primigenius*, received from Professor Ponzi, by whom it was discovered *in situ*, in the volcanic gravel deposit of Monte Sacro.[1] On visiting Rome in the spring of 1859, I saw abundant proofs of the accuracy of M. Lartet's correction, in the rich private collections of Professor Ponzi and Signor Ceselli, in the University Museum of La Sapienza, and in Kircher's collection in the Jesuits' College. The authenticity of the localities was placed beyond question, by the volcanic matrix of the specimens showing crystals of Pyroxene and nodules of decomposed Leucite. As this is a point of weighty importance in reference to the geographical range of *E. primigenius*, it may be well to adduce some instances of the evidence in support of it. The first is a fragment in the collection of Signor Ceselli comprising the anterior two-thirds of an unworn penultimate upper molar, presenting nine collines, very attenuated and closely compacted, seven of them being presented within the space of 3·2 inches, giving an average of about ·46 inch to each. The enamel is very thin, and the digital terminations are slender and numerous, there being about nine to each colline. This specimen is undistinguishable in its character from a Mammoth's tooth of the same age from Siberia, or an English gravel bed. It was found in the volcanic gravel bed of Ponte Molle, and the matrix abounds in Pyroxene and Leucite. Another is a specimen presenting the anterior half of a penultimate lower left true molar, with ten ridges, all

[1] Bullet. Société Géologique de France, 2e série, tom. xvi. p. 565.

more or less worn, within a space of 4·5 inches, yielding an average of ·45 inch to each. The typical characters of *E. primigenius* are most distinctly shown in the thin transverse attenuated plates of enamel, free from any tendency to crimping. The matrix is of a fine greyish-yellow sand, full of grains of pyroxene. It was found on Monte Sacro, near Ponte Nomentano, and is preserved in the Museum of La Sapienza. The same collection contains several other specimens of the same form, of which I find detailed descriptions in my notes. But the great mass of the Elephant molars contained in the collections of Professor Ponzi and Signor Ceselli, and in the Roman museums generally, belong to *Elephas antiquus*,[1] which occurs alike in the older Pliocene deposits of Rignano, and in the volcanic gravels of the Campagna. Here, therefore, we have unquestionable evidence that *E. primigenius* inhabited Central Italy, when the extinct Latian volcanoes were in full action. There are no data for correlating with precision this epoch with that of the Norfolk 'Forest-bed,' but it reaches as far back nearly as the close of the Pliocene period.

On the other hand, in the Alpine valley of the Chiana, in Tuscany, I met with decisive evidence that *E. primigenius* had survived in Italy down to a comparatively modern period. The Museum of Arezzo contains a mutilated cranium of this species, presenting all the basilar portion from the occipital condyles on to the incisive bones, both the maxillary bones, together with the palate and the two last true molars *in situ*, on either side, of an old animal. The specimen exhibits the most typical characters of the Mammoth throughout. The same collection includes lower jaws, detached molars, an entire humerus, and a radius and ulna of the same form. Some of these remains were very fresh-looking in colour, although adhesive to the tongue. Along with them, in the same turbary deposit, were found eight frontal fragments with the horn-cores of *Bos primigenius* and three of *Bison priscus*; and in the University Museum of Bologna, I saw an undoubted skull of *Cervus euryceros* (the Irish Elk), from the same localities in Val di Chiana. It is worthy of remark, that in no one of the Italian museums, from Naples to Turin, did I detect a trace of *Rhinoceros tichorhinus*, although with an eye specially directed in search of it. I carefully examined Monti's lower jaw, referred to by Cuvier, as being of that species,[2] and I can affirm, with confidence,

[1] 'I did not find a single tooth of *E antiquus* in the whole palæontological collection of the Florence Museum. (*Letter to M. Lartet, Florence, July* 17, 1856).—[Ed.]

[2] Oss. Fossiles, 4to. tom. ii. p. 73. Tab. ix. fig. 10. Prof. Capellini obligingly gave every facility for the examination of the specimen, by removing the enveloping matrix.

that it belongs to another extinct form. It is preserved in the Museum of Bologna. With the exception of *R. tichorhinus*, the fossil fauna of the Val di Chiana exhibits all the leading forms of the large Ungulata that accompanied the Mammoth in the north of Europe, before its final extinction.

Passing over the superficial deposits of Central and Northern Europe, I shall refer briefly to the Mammoth deposits of Siberia and the Ural mountains. The nature of the accumulations of the bones of Elephants and other northern quadrupeds at the mouths of the Siberian rivers is so well known, through the writings of Pallas and other naturalists and travellers since his time, that it is only necessary to allude to one leading fact, namely, that besides the freshness of condition in which they are preserved, the Siberian Fauna, as a whole, agrees with that of the 'low level gravels' of the river valleys and 'superficial drift' of the last stage of the Glacial period in Central Europe, and that it has not yet been shown to contain any of the older extinct species, like the *Elephas antiquus*, *Rhinoceros megarhinus*, or *Hippopotamus major*, which are found along with the early form of the Mammoth, in the pre-glacial 'forest-bed' of the Norfolk coast, or in the volcanic gravels around Rome.

The authors of the 'Geology of Russia' have, in their great work, investigated with much ability the nature and origin of the auriferous gravels, in which Mammoth bones occur on the flanks of the Ural mountains. They infer that the species had existed for a long course of ages upon the adjoining high lands, when the low region now skirting the Polar Sea was submerged; that the vast quantities of fossil bones found near the mouth of these rivers are the result of the secular accumulation, during a long period, of carcases floated by floods from the highlands into the great estuaries; and that the last elevations of the Urals, which led to the production of gold veins, were probably the chief causes that conduced to the final destruction of the Mammoth in Siberia.[1] But the leading general fact, observed with regard to the Siberian fossil fauna, holds equally good of that of the auriferous gravel deposits, of local origin, on the flanks of the Urals: *Elephas primigenius*, *Rhinoceros tichorhinus*, *Bison priscus*, *Equus*, &c., are the prevailing forms. Not an instance has been adduced of the older associates of the Mammoth, above-mentioned, having been found among these remains. *E. primigenius* has become extinct in the swamps of North America and in the valley of the Tiber, where auriferous gravels and Ural upheavements had no

[1] Geology of Russia in Europe, &c p 492, *et seq*

share in producing the effect. The disappearance of the species must be sought for in causes of a more general scope.

M. Lartet, in his very able and suggestive essay 'On the Ancient Migration' of the existing Mammiferous Fauna of Europe,[1] takes the inference of these authors as his starting point, and carries it further than appears to have been intended by them. He avers that the remains of *E. primigenius* and *Rhinoceros tichorhinus* have nowhere in Europe been discovered, except in deposits of a more modern age than the Northern drift; and that these species did not make their appearance among us until *after* the emergence of the drift-covered plains of western Russia, at the close of the Glacial period; in short, that the Fauna was first *tertiary* in the north of Asia, and then became *quaternary* in Europe. But this very ingenious argument is at once negatived by the fact, that we have unquestionable evidence that the Mammoth existed in England before the deposition of the 'Boulder-clay,' as the cotemporary of Mammalian species, handed down from the Pliocene period.

On a review of the data which we possess at the present time, it would appear that there is not a tittle of proof that *E. primigenius* has been met with anywhere in Europe or Asia, in deposits of an older date than the 'Forest bed' of the Norfolk coast. The Mammoth is emphatically entitled to the significant name proposed by Geoffrey St. Hilaire, in one of the bright inspirations of his latter years, of '*Dicyclotherium*,' as having by a 'miracle of Providence' survived through two epochs.[2] The geographical range of its associate *Rhinoceros tichorhinus* was greatly more restricted. It has never been observed in America, nor as yet in Italy.[3] The same restriction appears to apply to its range in time; I have seen nothing as yet to satisfy me that it existed in the Fauna of the 'Forest-bed' of Norfolk. The negative evidence, in a case of this kind, is of little value, since it proves nothing more than the limit of our positive knowledge up to a given time; but the asserted instances of its occurrence [4] are regarded by me as erroneous identifications, and as belonging to a more ancient extinct species.

[1] Comptes Rendus, tom. xlvi. Séance, 22 Février, 1858.

[2] *Op. cit.* Séance, 23 Janv. 1837.

[3] *Extract from Dr. Falconer's Notebook.*—'May 8, 1859 In the Museum of the Collegio Romano at Rome there is the germ of an upper left molar of *R. tichorhinus* and two detached lower molars of the same species. They have no labels and their origin is unknown, but their yellow ochre matrix is exactly like that of the Kent's Hole specimens. In specific characters they differed from all specimens found near Rome with which I compared them.'—[ED.]

[4] Brit. Foss. Mam. pp. 347 and 364.

§ 7. Earliest Head-quarters of the Mammoth—where?

Another question comes up for discussion. On what ancient land was the first dwelling-place of the Mammoth? Whence did it radiate through the vast geographical area included within its ascertained range of habitat? The prevailing impression, at the present time, appears to be in favour of the high land of Northern Asia. But I know not upon what good grounds it can be sustained. That the species existed there in great force, during a long lapse of time, has been clearly established; and it seems equally clear, that it spread from that area into America, by Behring's Straits or the Aleutian Isles, before the severance of the two continents took place, surviving, in North America, down to a date that would correspond with the superficial lacustrine marls and ancient peat-bogs of Europe. But the cast of the North Asiatic fauna, as shown above, is so entirely modern as to have been regarded by Lartet as being that of the ancestors of our existing European mammalia. The Sub-Uralian deposits have, as yet, supplied no consistent evidence of Pliocene strata or Pliocene mammalia, by means of which the Mammoth-yielding and auriferous gravels may be synchronized with, or differentiated from, the newer Pliocene strata of England, in which the Mammoth occurs along with species of an older age. At present there is a wide gap, in the formations other than marine, between the Miocene strata along the shores of the Black Sea, which, at Nicolajew in the Chersonese, near Odessa, have yielded the greater portion of the skeleton of a *Mastodon Tapiroïdes*,[1] and the Ural gravels containing bones of *E. primigenius* and its usual associates.

But there are strong grounds to suspect that Pliocene deposits exist on the western flanks of the Ural mountains, the geological history of which still remains to be unfolded. Pallas, in his 'Observatio de dentibus molaribus ignoti animalis, &c., ad Uralense jugum repertis,'[2] which Lartet refers to *M. Borsoni*,[3] distinctly states that the two molars were found in a horizontal stratum of indurated sandy and ochreous iron-ore which is worked on the bank of the Schebysy, an affluent of the Bjelaya, on the western slope of the Urals. The Vergennes and Abbé Chappe molars, figured by Buffon in the 'Notes Justificatives,' appended to 'Les Époques de la Nature,' the former procured from 'Little Tartary,' and the latter reputed to be from Siberia (or the Crimea ?),

[1] Quart. Jour. Geol. Soc. Vol. xviii. (Translations, &c.) p. 13. [See *antea*, p. 65.—Ed.]

[2] 'Acta Pretropolitana,' 3d Ser., 1777, tom. i. p. 213, tab. ix. fig. 4.

[3] Bullet. Societ. Géol. de France, 2e Sér. tom. xvi. p. 484.

confirm the statement of Pallas, both being of *M. Borsoni*; and Lartet tells us that he had identified with certainty, as of *E. meridionalis*, the fragment of a molar lately received by M. Ravergie from St. Petersburg, adding that the specimen is encrusted with the same ferruginous, sandy, and ochreous matrix, as described by Pallas.[1] *M. Borsoni* is a constant Pliocene species; occurring in Italy in the same Sub-Apennine beds which yield *E. meridionalis*; in France, below them; and according to Pallas, in Russia, in beds at a lower level than those which yield the Mammoth. The evidence, therefore, slight and imperfectly defined though it be, gives the forecast of the same order of succession upon the slopes of the Urals as in Europe, namely, subaerial beds, containing remains of the Pliocene mammals of Italy, and above them Mammoth-yielding deposits of the age of the Glacial period.

It is now well ascertained that after the Miocene period great alterations in the relation of land to sea took place in the regions stretching eastward from the shores of the Black Sea, beyond the Caspian and the Lake of Aral. We have also undoubted evidence that the true Elephantine Proboscidea, exclusive of numerous species of *Stegodon* and *Mastodon*, existed in India during the Miocene period. The same fossil fauna has been traced from Burmah, north along the foot of the Himalayahs to the frontier of Afghanistan, and thence southward, along the Sooliman range to the promontory bounding the estuary of the Indus to the west. But from this point westward to the shores of the Black Sea, and from the Hindoo-Koosh to the Caucasus, the entire region, including Persia, Arabia, Turkistan, Armenia, and Asia Minor, is almost wholly unexplored, so far as the extinct mammalia of the Pliocene and Quaternary periods are concerned. Is it not probable that when this vast tract is better known, the fossil Elephants of Europe and Northern Asia may be traced back towards their Miocene head-quarters in India? Where the ground has been broken facts of much interest have been yielded. During the Crimean war, Colonel J. M. Giels, in passing through the province of Erzeroom in Armenia, discovered, close to a village called Sharvoon, near Khanoos, some remnants of a fossil Elephant which he presented to the British Museum. Major R. Jones Garden, F.G.S., being soon after on a tour in Asia Minor, and having courteously offered his services, proceeded at my request to the locality, to make further explorations. The remains indicated that the skeleton of the animal had lain in the cliff

[1] *Op. cit* pp. 500 and 516.

of a ravine, about twenty-five feet in height, the section consisting of alternate beds of clay and fluviatile sand, the latter charged with fragments of *Dreissena.* The bones were in a very friable condition, and the skull crushed and decomposed; but Major Garden was able to exhume some portions of tusks six-and-a-half inches in diameter, which in desiccation crumbled to pieces. The specimens presented by Colonel Giels to the national collection consist of two last upper molars in fine preservation, and a portion of a lower molar, all apparently of the same individual. These molars strike a practised eye, at the first glance, as presenting something intermediate between the Mammoth and the existing Indian Elephant. The case is of so much interest, that I shall venture on some of the details. The left upper molar (m. 3, being No. 32,250 Museum Regist. Palæont. Gallery) is entire from behind the large front fang, the portion borne upon which had been ground down by protracted wear.[1] The anterior part of the crown to the extent of 2·7 inches is also worn out, presenting merely a smooth surface of ivory, behind which there are seventeen ridges and a posterior talon. Of these, fifteen are more or less worn. The anterior nine form transverse narrow discs; the next six are divided nearly equally by two rather wide longitudinal channels into three divisions, consisting each of a flattened elliptical disc. The transverse discs, in their general character, bear a close resemblance to those of the Indian Elephant, the enamel-plates being rather thick, with very pronounced close-set crimping in the middle, but diminishing towards the cornua. These discs are narrower than is commonly seen in the existing species, less open and less parallel across. The crown is broad, and the enamel-plates are high. To render these descriptive details more appreciable and available for comparison, I append the principal dimensions:—

Extreme length of crown, 11·75 in. Length of crown-surface in use (partly worn out), 9·5 in. Space occupied by the anterior ten discs measured at top of crown, 5·7 in. Ditto ditto at base of crown, 6·1 in. Width of crown at 3rd ridge (greatest), 4·1 in. Ditto at 11th ditto, 3·7 in. Height of crown at 12th ridge, 7·1 in.

These Khanoos molars are intermediate in character between the Mammoth and the Indian Elephant, but more nearly allied to the latter. The specimens are in a perfectly fossilized condition, the ivory being of a salmon colour, with dark mottled patches, like those which accompany dendritic crystallizations, and they are strongly adherent to the tongue. That they are true fossils is confirmed by the fact of Major Garden having found the tusks *in situ.* Elephant tusks, six-and-a-half inches in diameter,

[1] Pl. x. fig. 3, shows the crown-view of the tooth.– [Ed.]

are too valuable to have been left by man to decay along with the skeleton of a domesticated Elephant. In the synoptical table appended to my Memoir on the 'Species of Mastodon and Elephant, &c.,' the Khanoos fossil form is ranged between *E. Indicus* and *E. primigenius*, under the provisional name of *E. Armeniacus*.[1] Captain Spratt, whose indefatigable labours along the shores of the Mediterranean and Black Sea have been productive of such valuable and varied results, ascertained that remains of a fossil Elephant had been discovered on the banks of the Bosphorus; but the species has not as yet been determined. I have entered on such detail on this point to direct attention to an imperfectly explored region, which promises to yield important results.[2]

The northern shores of the Black Sea and the Sea of Azof have yielded indications of the remains of fossil Elephants, the specific identification of which remains to be determined. Lartet refers to molars of *E. meridionalis*? as having been dug up in the trenches before Sebastopol;[3] and Huot mentions the discovery of Elephant bones at Sympheropol, which he assigns to *E. primigenius*, employing the term in the loose comprehensive sense in which it used to be applied to all fossil Elephants met with over the European area.[4] The same remark applies to the Mammoth remains mentioned by the authors of the 'Geology of Russia,' as occurring in the stratum of 'clay-drift' which rests upon the Miocene steppe limestone at Taganrog, on the shores of the Sea of Azof.[5] It is greatly to be desired that the species of Elephant occurring in these cases should be accurately ascertained. The fact, that so eminent a Proboscidean authority

[1] Quart. Journ. Geol. Society, 1857, vol. xiii. p. 319. [See *antea*, p. 14.—Ed.]

[2] The 'Khanoos' and Bosphorus fossil Elephants appear to furnish an explanation of the statements of Pausanias, respecting the gigantic bones of Geryon, and large horns (Elephant-tusks) found near the banks of the Hyllus, in Upper Lydia; and of the colossal bones of the Indian Orontes, together with a gigantic horn, brought to light by digging a deep canal, when a Roman Emperor tried to pass a fleet to Antioch up the Orontes. For the former case, *vide* Pausan. Attic. Lib. i. cap. xxxv.; and for the latter, *idem*. Arcad. Lib. viii. cap. xxix. Also Cuvier, Oss. Foss. 4to. tom. i. p. 152, 3rd Edit.

[3] Bullet. Sociét. Géolog. de France, 3d. Sér. (1859) tom. xvi. p. 500.

[4] Demidoff's 'Voyage dans la Russie Méridionale,' &c. tom. ii. pp. 457 and 564.

[5] *Op. cit.* vol. i. p. 502. The authors of this great work appear to consider the Taganrog deposit in question, which they term 'Clay-Drift,' or 'Mammoth-Drift,' to be identical with the 'Mammoth-Drift' of Central and Southern Russia, and to have been a result of submergence, like that of the Lowlands of Northern Siberia, when Mammoth bones were transported into its estuaries. But it still remains to be proved that the Arctic Ocean of the Glacial period ever invaded the Aralo-Caspian province of which the Sea of Azof was a part. We have the high authority of Woodward for the fact that the Aralo-Caspian basin contains only a single species (*Cardium edule, var. rusticum*) common to it and the White Sea. ('Manual of Mollusca,' p. 431). Huot considered the Crimean deposits, yielding Elephant remains, to be of freshwater origin.

as M. Lartet has approximatively referred the Sebastopol remains to *E. meridionalis*, coupled with the occurrence of *M. Borsoni* either in Siberia or the Crimea, is strongly presumptive of Pliocene beds, yielding Elephants of a much more ancient date than the Mammoth-yielding gravels of the Urals. The dentition of *E. meridionalis*, in the ridge-formula, is identical with that of the Miocene fossil *Elephas planifrons* of the Sewalik hills, and the characters yielded by the enamel-plates and discs of wear are also closely conformable; while *E. Armeniacus*, as stated above, approaches nearer to the existing Indian species.

There is another point connected with distribution of fossil Elephants over the European area, to which I am desirous of directing the attention of palæontologists. I now entertain a strong suspicion that remains of *E. Armeniacus*, or of a form closely allied to it, occur in Italy. This impression is founded upon specimens which I observed in the Natural History Museum of Turin, in the University Museum of Pisa, in the private collection of the Marchese Carlo Strozzi at Leghorn, and in those of Professor Ponzi and Signor Ceselli at Rome, the satisfactory specific identification of which puzzled me greatly. They certainly cannot be referred either to *E. meridionalis* or to *E. antiquus*, from the high numerical expression of their ridge-formula, nor do they appear susceptible of identification with *E. primigenius*, without straining the distinctive characters of that species to a degree which is not warranted by our experience of it elsewhere. The first which I shall adduce in illustration are a series of molars, discovered in the Astigiano, during the excavation of the railway section between Alexandria and Turin. One of them is a huge last upper molar, right side, in the finest preservation and half-worn. The crown is not quite perfect in front, the portion borne upon the large anterior fang having been worn down and broken off. What remains of it presents no fewer than twenty-four ridge-plates, including the hind talon; and of these the twelve anterior ones are more or less worn, the rest being intact. The crown is very broad in front, and the plates, where unworn, are very high, as will be seen by the dimensions annexed. The discs of wear are transverse, without mesial expansion; they are not so open as in the Indian Elephant, but wider than in the Mammoth, except in specimens of the latter worn low down; and they exhibit nothing of the retroflexion of the lateral cornua, commonly seen in *E. antiquus*. The enamel-plates are flexuose in the middle with decided crimping there, which does not extend to the sides; they are thicker than in *E. primigenius*, but less so than in *E. antiquus*. In this respect they

resemble most *E. Armeniacus* and *E. Indicus.* The space occupied by the twelve discs of wear, measured along the summit of the crown, is 7 inches, yielding an average of about ·6 inch to each, which comes very near that indicated above in the *E. Armeniacus* of Khanoos, *i.e.* ·57.

The principal dimensions are:—

Length of crown (not quite entire), 13·75 in. Extreme width of crown, 4·5 in. Height of crown at 12th ridge, 8· in. Space occupied by the 12 discs of wear, 7· in.

I have detailed notes of numerous other molars, exhumed on the same occasion, from the same locality, St. Paolo, or near it, 'Nizza della Paglia,' which yield similar characters. My first notes were taken in July, 1856, and in April, 1861, I re-examined the materials, the interval having afforded me ample opportunities of examining the molars of fossil Elephants over the European area. With the reserve suggested by the fact, that I have not been able to confront the originals, or good drawings of them, I have been led to identify the 'Khanoos' and St. Paolo molars as being of the same species, *E. Armeniacus*, and to consider that they are not referable either to *E. primigenius* or *E. antiquus*[1]. The same remark applies to specimens which I examined along with Prof. Meneghini in the Museum at Pisa; to a specimen of which I saw a cast in the possession of Marchese C. Strozzi, the original procured from the Val di Mugello, an affluent of the Sieve; and to specimens in the possession of Professor Ponzi and Signor Ceselli, from the volcanic gravels around Rome. I may further add, that I failed to distinguish from the existing Indian Elephant the last milk molar, from the Grotta of San Teodoro, in the lower jaw figured by my friend Baron Anca;[2] and that I discovered in the Grotta of Maccagnone a last upper milk molar, presenting similar characters; neither is reconcilable with *E. primigenius* or with *E. antiquus.* I dwell upon these facts in the hope that the attention of Italian palæontologists may be attracted to the subject, and that they may follow up the investigation. We now possess, through the accurate researches of M. Lartet, conclusive evidence that the existing African Elephant formerly extended its range to Southern Europe; and it would hardly be more unexpected to find that the Indian Elephant, or a form closely allied to it, had ranged into Asia Minor and Italy.

[1] See *antea*, pages 187 and 192, *note*.—[Ed.]

[2] Bullet. Sociét. Géol. de France, 2e Sér. tom. xvii. p. 684, Pl. xi. figs 8 and 8 *a*.

§ 8. PERSISTENCE IN TIME OF THE DISTINCTIVE CHARACTERS OF THE EUROPEAN FOSSIL ELEPHANTS.

Having long enjoyed the privilege of intimate intercourse with Charles Darwin, I have been for many years familiar with the gradual development of his views on the Origin of Species; and I have been included by him in the category of those who have vehemently maintained the persistence of specific characters. My attention has, in consequence, been closely directed to the evidence yielded by the Pliocene and Quaternary deposits of Europe in its bearing on the question, in so far as the fossil Mammalia are concerned.

Commencing with the older Pliocene strata of the Sub-Apennines and of the Val d'Arno, and ascending to the superficial gravels or quaternary deposits of comparatively modern origin, at least four well-defined species of fossil Elephant have been ascertained to have existed in Europe, namely, *E.* (*Loxodon*) *meridionalis*, *E.* (*Euclephas*) *antiquus*, *E.* (*Euelephas*) *primigenius*, and *E.* (*Loxodon*) *Africanus fossilis.*[1] A vast number of remains of the three first named of these species have been exhumed over a large area in Europe; and, even in the geological sense, an enormous interval of time has elapsed between the formation of the most ancient and the most recent of these deposits, quite sufficient to test the persistence of specific characters in an Elephant. Do then the successive Elephants, occurring in these strata, show any signs of a passage from the older form into the newer? or what light do they throw on the general question?

It is obviously beyond the scope and limits of the present communication to enter at length on the details of this great

[1] I omit from the list *E.* (*Loxodon*) *priscus* (*vide* Synop. Table, Quart. Journ. Geol. Soc. 1857, vol. xiii. p. 319*), which I now regard as being a form of *E. antiquus*, and *E. Armeniacus*, or the fossil Elephant of Sicily and Italy, which is closely allied to the existing Indian species, in order to relieve the argument of any elements which may not be considered as being at present established on sufficient evidence. I omit also an undescribed fossil Elephant from the ossiferous caves of Malta, which is in some respects the most remarkable and unexpected form that has yet been discovered, fossil or recent. The conception of an Elephant is associated in the mind with the familiar idea of colossal size. *E. Melitensis*, the name which I have applied to the new species, was the pigmy form of the order. I am in possession of a last cervical vertebra of an adult animal, the body of which does not exceed 2·8 inches in vertical diameter, and 0·95 in thickness, with a humerus of a younger, but nearly adult individual, the entire length of which was not more than 10 inches. The species was discovered through the researches of Capt. Spratt, C.B., of H.M. ship 'Medina,' to whose indefatigable labours in the Mediterranean Science is so deeply indebted. The discovered remains, now entrusted to my charge, include nearly the entire dentition, from the new-born calf up to the adult animal, of numerous individuals. In the Systematic Series, it belonged to the subgenus *Loxodon*, and in size, stood between a large Tapir and the small unicorned Rhinoceros of Java.

* *Antea*, p. 14.—[ED.]

argument. I shall confine myself briefly, and with diffidence, to the results to which one observer, whose attention has been earnestly fixed on the subject, has been conducted.

If there is one fact, which is impressed on the conviction of the observer with more force than any other, it is the persistence and uniformity of the characters of the molar teeth in the earliest known Mammoth, and his most modern successor. They maintain unchanged the same numerical formula of the colliculi, in the successive teeth; the same great breadth of crown relatively to its length; the same condensation of the constituent materials; the same narrow parallel-sided transverse bands in the discs of wear; the same general absence of crimping in, and tenuity of, the enamel-plates; and uniformly the same flatness of the plane of wear. It may be urged, that the observation is here limited to the characters of a single organ, and that to justify any well-founded generalization, the comparison should be carried throughout the skeleton. The objection would apply forcibly in the case of living forms; not merely the skeleton, but the soft parts, and the texture and colouring of the dermal appendages, would all require to be taken into account. But with fossil forms this is manifestly impossible. The compass of a single life would hardly suffice, even, for a rigorous comparison of the details of the skeleton in all the geographical localities and geological deposits in which the remains of the Mammoth have been found. The observer is thus constrained to a selection. Through a wide range of observation on living forms, we know the constancy with which the characters of the teeth are maintained in the same species; and having faith in the order of nature, we extend the rule to extinct forms. The result of my observation is, that the ancient Mammoth of the pre-glacial 'Forest-bed' of the Norfolk coast differs less from the later form occurring on the banks of the Lena, than does the latter from the comparatively modern Mammoth of the superficial bogs of North America, which I regard as being only a slight geographical variety of the same species.

The same evidence, I believe, is borne by the organs of locomotion; but the exposition of this part of the case is beyond the limits of the present occasion.

Assuming the observation to be correct, what strong proof does it not afford of the persistence and constancy throughout vast intervals of time, of the distinctive characters of those organs which are most concerned in the existence and habits of the species? If we cast a glance back on the long vista of physical changes which our planet has undergone since the Neozoic Epoch, we can nowhere detect signs of a

revolution more sudden and pronounced, or more important in its results, than the intercalation and subsequent disappearance of the Glacial period. Yet the 'dicyclotherian' Mammoth lived before it, and passed through the ordeal of all the hard extremities which it involved, bearing his organs of locomotion and digestion all but unchanged.

Taking the group of the four European fossil species above enumerated, do they show any signs, in the successive deposits, of a transition from the one form into the other? Here again, the result of my observation, in so far as it has extended over the European area, is, that the specific characters of the molars are constant in each, within a moderate range of variation, and that we nowhere meet with intermediate forms. The specific difference in the molars, be it observed, rests upon a much more deep-seated foundation than the superficial indication, merely, of 'thick-' and 'thin-plated' varieties. This I shall endeavour to explain with the help of figures. Taking *Mastodon Ohioticus* at one end of the chain, and *E. primigenius* at the other, the number of ridges in the last milk molar and in the three consecutive true molars yields, in the former, the ciphers 3 : 3, 3, 4; while in the latter, they rise to 12 : 12, 16, 24. The groups of forms interposed between these extremes yield intermediate numerical formulæ, which are very constant in each species, within a moderate range of individual variation. Thus, the *Mastodon Arvernensis* gives 4 : 4, 4, 5; *Elephas* (Lox.) *meridionalis*, 8 : 8, 9, 12; *E.* (Lox.) *Africanus*, 7 : 7, 8, 10-11; *E. antiquus*, 10 : 10, 12, 16. We nowhere find in the sucsuccessive deposits in Europe, indications of a transition from *E. meridionalis* to *E. antiquus*, which could be represented by a formula between 8 : 8, 9, 12; and 10 : 10, 12, 16; nor between the latter species and *E. primigenius* by a formula intermediate to 10 : 10, 12, 16, and 12 : 12, 16, 24. The difference is so great, that the penultimate upper true molar (m. 2), which in *E. meridionalis* does not exceed 9 ridges, attains in the Mammoth 16. And it is further to be borne in mind, that these numerical distinctions in the divisions of the crowns of the molars are accompanied by other specific characters which are equally constant.

The inferences which I draw from these facts are not opposed to one of the leading propositions of Darwin's theory. With him I have no faith in the opinion that the Mammoth and other extinct Elephants made their appearance suddenly, after the type in which their fossil remains are presented to us. The most rational view seems to be, that they are in some shape the modified descendants of earlier progenitors. But if the asserted facts be correct, they seem clearly to

indicate that the older Elephants of Europe, such as *E. meridionalis* and *E. antiquus*, were not the stocks from which the later species *E. primigenius* and *E. Africanus* sprung, and that we must look elsewhere for their origin. The nearest affinity, and that a very close one, of the European *E. meridionalis* is with the Miocene *E.* (*Loxod.*) *planifrons* of India; and of *E. primigenius* with the existing Indian species. Another reflection is equally strong in my mind, that the means which have been adduced to explain the origin of species by 'Natural Selection,' or a process of variation from external influences, are inadequate to account for the phenomena. The law of Phyllotaxis, which governs the evolution of leaves around the axis of a plant, is nearly as constant in its manifestation as any of the physical laws connected with the material world. Each instance, however different from another, can be shown to be a term of some series of continued fractions. When this is coupled with the geometrical law governing the evolution of form, so manifest in some departments of the animal kingdom, *e.g.* the spiral shells of the Mollusca, it is difficult to believe that there is not in nature a deeper seated and innate principle, to the operation of which 'Natural Selection' is merely an adjunct. The whole range of the Mammalia, fossil and recent, cannot furnish a species which has had a wider geographical distribution, and at the same time passed through a longer term of time, and through more extreme changes of climatal conditions, than the Mammoth. If species are so unstable, and so susceptible of mutation through such influences, why does that extinct form stand out so signally a monument of stability? By his admirable researches and earnest writings, Darwin has, beyond all his cotemporaries, given an impulse to the philosophical investigation of the most backward and obscure branch of the Biological Sciences of his day; he has laid the foundations of a great edifice; but he need not be surprised if, in the progress of erection, the superstructure is altered by his successors, like the Duomo of Milan, from the Roman to a different style of architecture.

§ 9. Unity or Plurality of Species in the existing Asiatic Elephants.

This question has an important bearing on that of the fossil species which we have just discussed. It is averred, that from the time of Cuvier up to the present day, zoologists have been commonly in error in regarding the Elephants of Eastern Asia as all belonging to one species, *E. Indicus*; that there are two well marked forms confounded under this name, the one limited to Continental India, the other insular,

called *E. Sumatranus*, inhabiting Sumatra and Ceylon and probably extending also to the Trans-Gangetic portion of the Continent. Let us see upon what evidence these assertions are founded.

The opinion, so far as I am aware, was first broached, but in a very general and conjectural way, by Mr. B. H. Hodgson, the eminent ethnologist and explorer of the zoology of Nepaul, who, in a communication to the Zoological Society, in 1834, suggested that there are two varieties, or 'perhaps rather species,' of the Indian Elephant, the Ceylonese and that of the Sàl forests: the Ceylonese having a smaller and lighter head, which is carried more elevated, and having also higher fore-quarters; while the Elephant of the Sàl forests has sometimes five nails on its hinder feet.[1]

In 1847, Temminck brought out a work embodying a general survey of the resources and productions of the Dutch East India possessions, in which there appeared a brief notice of a supposed new species of Elephant, named *E. Sumatranus*.[2] As Temminck's strength as a naturalist lay in ornithology, the announcement did not carry with it the weight of authority, when opposed to the opinion of Cuvier and other eminent zoologists. But it now appears that the inference originated with the distinguished Dutch zoologist, Professor Schlegel, and that Temminck's work was simply the vehicle in which the results arrived at by the latter first appeared.

In 1847 I visited Leyden, for the express object of examining the materials preserved in the Museum there, upon which *E. Sumatranus* was founded; by the aid of Prof. Van der Hoeven I was enabled to see them, although only in a cursory manner, owing to the shortness of the time at my disposal; but the inspection failed to satisfy me that *E. Sumatranus* was distinct from the Continental Indian Elephant, with which I had been familiar in its native haunts, during many years.

In 1849, the late Prince of Canino (Charles L. Buonaparte) made a communication to the Zoological Society, in which he affirmed that *E. Sumatranus* of Temminck was intermediate between the Continental Indian and African Elephants; and that the differences in the form of the skull and in the teeth were so pronounced as to put an end with certainty to the subgeneric distinction between *Elephas* proper and *Loxodon*.[3] But there are errors of statement in the Prince of Canino's brief notice which divest it of the

[1] Zoological Proceedings, 1834, p. 96.

[2] 'Coup d'œil général sur les Possessions Neederlandaises,' &c. 8vo. 1847, tom. ii. p. 91.

[3] Proceed. Zool. Soc. 1849, p. 144.

authority of accurate or original observation. He even asserts that the 'undulated ribbons of enamel are nearly quite as wide as those forming the lozenges of the African.'

Last year, Professor Schlegel, whose attention has been continually directed to the subject since 1845, communicated a paper to the Academy of Sciences of Holland, in which he lays claim to the authorship of the opinion first put forward in Temminck's work, and maintains it upon extended observation.[1]

In order to facilitate their examination, I shall classify the distinctions which have been adduced, from first to last, in support of the view, although some of them have been abandoned in the progress of the inquiry.

I. *External characters.* — Small ears and general form, both, as in the Continental Elephant; but the Sumatran species more slender and more finely built; trunk longer and more slender; extremity of the tail more dilated, and invested with longer and stronger bristles, in this respect reminding one more of the African than the Indian species. (Schlegel.)

II. *Greater degree of intelligence and aptitude for instruction.* (Diard in Schlegel.)

III. *Osteological characters.*

(A.) General construction of the skeleton and form of the cranium alike, but:

1. Free part of intermaxillaries shorter and narrower.
2. Nasal aperture more contracted.
3. Inter-orbital space narrower.
4. Posterior part of the cranium wider. (Schlegel in Temminck.)
5. Form of skull intermediate between African and Indian. (C. L. Buonaparte.)

(B.) *Molar teeth.*—Ribbons (discs of wear) in form like those of the Indian species, *i.e.* the enamel-plates highly crimped, parallel, and free from the rhomb-shaped expansion of the African Elephant; but the ribbons wider (in the direction of the long axis), and *consequently less numerous than in the Indian species*; the difference being in the ratio of 3 or 4 : 1 in the Sumatran, and 4 or 6 : 1 in the Continental Indian form (Schlegel in Temminck). Ribbons of enamel nearly quite as wide as in the African Elephant. (C. L. Buonaparte.)

(C.) *Vertebræ and ribs.*—The following numerical differences have been indicated by Prof. Schlegel; they vary in some unimportant respects, according to the statements of different dates :—

[1] 'Bijdrage tot de Geschiedenis van Olifanten, voornamelijk, *Elephas Sumatranus*,' translated by Dr. Sclater, Nat. Hist. Review, 1862, vol. ii. p. 72.

	African Elephant		Sumatran Elephant		Indian Elephant	
	In Temminck	Schlegel	In Temminck	Schlegel	In Temminck	Schlegel
Cervical vertebræ	7	7	7	7	7	7
Dorsal vertebræ .	21	21	20	20	19	19
Lumbar vertebræ .	3	3	3	3	3	3
Sacral vertebræ .	4	4	4	4	5	4
Caudal vertebræ .	26	26	34	33	34	33
True ribs[1] . .	6	5	6	5	6	5
False ribs . .	15	16	14	15	13	14
Pairs of ribs .	21	21	20	20	19	19

According to this table, the Continental Indian Elephant has only 19 dorsal vertebræ and 19 pairs of ribs; while the Sumatran species has 20 of each, the African Elephant having 21; being differences which, if proved to be constant, would be of considerable systematic importance.

The difference in external form between the Indian and African species is so pronounced, that either can be told off at a glance even from the stamp of a Greek or Roman coin. Admitting the general form and small ears to be alike in the Indian and Sumatran Elephants, Professor Schlegel has only a slight difference in slenderness of the general proportions, a more slender form of the trunk, and a larger terminal fringe of bristles to the tail,[2] to rely upon. But even in the Sàl forests of North Western India, at the extreme northern limit of the species at the present day, the difference of slender-built and squat-built Elephants is well known, being expressed by Corse, for the Bengal variety, under the designation of '*mirghi*,' or Cervine for the former, and '*Koomarea*' for the latter, or when the characters are combined '*Sunkareah.*'[3] The trunk varies in a similar manner, being

[1] Schlegel expressly states, 'that the number of true ribs is alike in all the species, that is only five;' but there is evidently a numerical slip in the ciphers which he immediately afterwards assigns to the false ribs, namely, 15, 14, and 13 respectively, in the three different species, which would give a total of 20, 19, and 18, instead of 21, 20, and 19, being the asserted aggregate of pairs corresponding with the assigned number of dorsal vertebræ in the different species. (Nat. Hist. Review, vol. ii. p. 75.)

[2] The distinctions indicated were, according to the statement of Prof. Schlegel, founded on the observation of Heer Westermann, upon two female Elephants in the Zoological Garden at Amsterdam, the one from Calcutta, the other Sumatran. It must be admitted, that the number of objects compared is hardly sufficient to sustain the position. The original passage in Schlegel's memoir is thus:—'Dat het een' langeren en dunneren snuit heeft; dat de Staart aan het einde meer afgeplat en met langere, zware haren bezet is,' &c. The version given in the 'Nat. Hist. Review,' is 'that the *rump* at the end is more broadened, and covered with longer and stronger hairs' (*Op. cit.* p. 76). In Tennent's 'Natural History of Ceylon,' the character of flattening with longer hair is made to apply to the extremity of the *proboscis,* instead of the *tail* (*Op. cit.* p. 66). The version given in the text is the correct one.

[3] Philosoph. Transacts. 1799, p. 205.

somewhat short and thick in some, and long and more slender in others. The fringe of bristles to the tail is variable in degree, according to the sex, age, and vigour of the animal. A good fringe is seldom retained long in captivity; when present, it always enhances the price of the animal in the estimation of the natives of India. That the animal varies considerably in appearance, according to the district in which he has been captured, has long been well known in India. Aboo Fuzl, in his account of the Elephant stables of Akbar, enumerates six varieties, distinguished by form, different marks, or colouring;[1] and the experienced mahouts attached to the Government Commissariat in Bengal will tell, at a glance, the district where a recently caught Elephant has been bred;[2] whether the Sàl Forests of the North-West Provinces, Assam, Silhet, Chittagong, Tipperah, or Cuttack. The distinction, therefore, founded upon the external characters of *E. Sumatranus*, completely fails.

I believe that the same could be shown, as regards the asserted difference of intelligence and aptitude for instruction; but as this is not a tangible, specific character, I leave it undiscussed.

The Osteological distinctions in the skull, which Professor Schlegel advanced in Temminck's work, he has since seen reason to abandon. But the identity of form is a strong argument in support of the unity of species. Not only is the general form of the cranium alike in both, but the relative proportions and connections of the constituent bones are the same in the wild Elephant of the North-West Provinces and in that of Ceylon. The difference of variety, implied by the terms '*Mŭkna*,' 'small-tusked,' and '*Dauntela*,' large-tusked, necessarily involves a proportional degree of difference, in the development of the intermaxillary bones, in the depth and breadth of the trough between the tusk-sheaths, and in the amount of development of the occipital bosses. But the connections of the bones remain the same; and all the leading modifications of form and proportion, so clearly indicated by Cuvier, as distinctive of the Indian from the African form, are maintained in the Continental and Ceylon Elephants, within a range of variation which is common to both.

The metropolitan collections furnish excellent and authentic materials for testing the accuracy of this statement in two magnificent skulls of adult wild Elephants, both killed in combat by gunshot wounds. The one (No. 2656,

[1] Ayeen-Akberry, translated by Gladwin, vol. i. p. 126.
[2] Hooker, 'Himalayan Journals,' vol. ii. p. 302.

Osteol. Cat.) is preserved in the Museum of the College of Surgeons, the other in the Zoological Department of the British Museum. The former is of a large Ceylon Elephant, which bears the open canals (one of them nine inches deep) of three bullet wounds, of old date, that had been repaired by nature, in addition to its recent death wounds; the latter, of a most destructive Solitary, or '*Goondah*' wild Elephant, which for a long time was the terror of a district near which I then resided. It was killed in the jungles, on the banks of the Ganges, at no great distance from Meerut, in May, 1833, by a party of four experienced sportsmen, who went out for the express purpose of killing it. The savage animal made no fewer than twenty-three desperate and gallant charges against a battery of at least sixteen double-barrelled guns, to which it was exposed on each occasion, and fell, after several hours, with its skull literally riddled with bullets. Besides the shot-holes of its last engagement, the frontal plateau alone bears, above the nasals, the healed canals of at least sixteen bullet-wounds received in previous encounters, exclusive of those effaced by the confluent fissures of its latest wounds. Meerut is in lat. 29°, close to the extreme northern limit of habitat of the Indian Elephant. If the two skulls, from localities so wide apart, are compared, they agree in general form and proportions, and also in the details of the pyramidal summit, long concave frontal plateau, inial fossa, occipital bosses, nasal aperture, position of the orbits, form and connections of the lachrymary, length of incisive sheaths, &c.

On the other hand, in all the well-determined species, fossil or recent, of which perfect crania are known, we invariably find that the latter yield strongly-marked distinctive characters even when molar teeth are similar. In illustration I may cite *E. primigenius*, *E. Indicus*, *E. Hysudricus*, *E. Namadicus*, *E. planifrons*, *E. meridionalis*, and *E. Africanus*, in no two of which are the crania alike; while in the Ceylon and Indian Elephants they are so closely similar, that, in a museum, without a record, the mere form will not instruct the observer whence the specimen came—whether continental or insular. The statement made in the Zoological Proceedings of 1849, as to the amount of difference, is clearly an exaggeration (*antea*, p. 255).

As regards the molar teeth, it is stated in Temminck's 'Coup d'œil,' in reference to the discs of wear, that, 'ces rubans sont de la largeur de ceux qu'on voit à la couronne des dents de l'Éléphant d'Afrique; ils sont conséquemment moins nombreux que dans celui du continent de l'Asie.' In

Professor Schlegel's later communication, the statement is modified as follows:—

'The laminæ of the teeth afford another distinction which however is less apparent to the eye than that taken from the number of vertebræ. These laminæ, or bands, in *E. Sumatranus*, are wider (or if one may so say, broader in the direction of the long axis of the teeth) than in *E. Indicus*. In making the comparison, one may remark that the distinction is less evident in younger individuals, and that there are met with, in all species of Elephants within certain definite limits, remarkable individual differences in respect of the width of these laminæ.' (Nat. Hist. Rev. ii. p. 75.)

Here, it will be observed, the distinction is propounded subject to so many qualifications, as to render it elusive for any practical use. I have ascertained, after the examination of a very large quantity of materials in India and Europe, that the ridge-formula in the Indian Elephant runs thus:—

$$\overbrace{\frac{4,\quad 8,\quad 12}{4,\quad 8,\quad 12}}^{\text{Milk molars.}} \cdot \overbrace{\frac{12,\quad 16,\quad 20\text{–}24.}{12,\quad 16,\quad 20\text{–}24.}}^{\text{True molars}}$$

The increase in the number of the ridges of the successive teeth takes place as in *E. primigenius*, by increments of 4, repeated in two series, the first of which terminates with the last milk molar. The second series commences with the antepenultimate or first true molar, which *constantly repeats* the number presented by the last milk molar, *i.e.* 12; the penultimate (m. 2) shows an increment of 4, the number of its ridges being normally 16. The last true molar never shows less than 20, commonly about 22, but sometimes, in the lower jaw, attaining as many as 27 ridges. This liability to variation in the last true molar is well known, and runs more or less through all the species of Elephant and Mastodon.[1] But the ciphers, shown above, are very constant, in the three intermediate molars (*i.e.* the milk molar and the antepenultimate and penultimate true molars), namely, 12: 12, 16. I do not mean to affirm that they are absolute and invariable; but that the above formula is a fair exponent of the results yielded by a great majority of instances, on the comparison of a very large quantity of materials. For example, the penultimate milk molar (m.m. 3) occasionally presents only 7 ridges; while the antepenultimate true molar of the lower jaw, in some cases, exhibits

[1] For illustrations of the fact in *Mastodon Ohioticus*, *vide* Warren, *Op. cit.* p. 79; and for its general occurrence in the family, *vide* Lartet, *Bullet. Géol. Soc de France*, 2e série, tom. xvi., note, p. 498.

as many as 14; the variation being dependent, partly on the greater or less development of the talon-ridges, which are very inconstant, and, as I have elsewhere stated, partly on the race, sex, and size of the individual.[1] I rest the more stress upon the importance of the ridge-formula, since, whenever the element of quantity can be shown to hold in the animal organization, it becomes a powerful aid to research and a criterion to test the accuracy of observation. In the fossil *E. antiquus* of Europe, the dentition of which I have been able to determine with precision, the formula for the three intermediate molars and the last true molar, above and below, is 10: 10, 12, 16, being nearly intermediate between the Indian and African Elephants. If then, as asserted, the number of bands (*i.e.* ridges) is less in the Sumatran and Ceylon form than in the Continental Indian, the ridge-formula ought to show a lower series of ciphers. Professor Schlegel tells us that he has had the advantage of examining at least seven skeletons, including young individuals, besides several skulls of *E. Sumatranus*, furnishing ample materials for determining the number of ridges in the different teeth. Yet neither he, nor any of the other advocates of distinctness of the species, has as yet attempted to show, by adduced instances, that the numbers are less; and until that is done, the general and therefore vague assertion of the fact cannot be admitted as of sufficient weight. In the skull of the large Ceylon Elephant above referred to (No. 2656. Osteol. Cat. Coll. Surg.) the last true molar above and below shows 22 ridges; a penultimate upper right molar, in the collection of Mr. Prestwich, and of undoubted authenticity as having been imported from Ceylon, still shows 15 ridges, although the most anterior portion is worn out, with the loss of one ridge; while the penultimate lowest of a Sumatran skull figured by De Blainville [2] distinctly shows 16 ridges, besides a hind talon. These instances prove, so far as they go, that the ridge-formula is the same in the Ceylon and Sumatran form as in the Indian.

Next, as regards the width of the bands (discs of wear). This is a most deceptive character if merely regarded *per se*, since it varies very considerably, even in the same molar, at different stages of detrition: 1st, because the ivory-cores of the ridges being wedge-shaped, the discs of wear are necessarily narrower at their apex than at their base; 2nd, because, as already stated (*supra*, p.238), the plane of abrasion,

[1] Quart. Jour. Geol. Soc., 1857. Vol. xiii. p. 315. (*Antea*, p. 5.—Ed.)

[2] Ostéographie: Éléphants. Pl. ix. fig. 6. De Blainville numbers the tooth as a 6th or last, but it is manifestly a 5th or penultimate.

instead of being perpendicular to the axis of the wedges, cuts them obliquely, the obliquity increasing with the advance of wear and constantly tending towards the horizontal. The consequence is, that the width of the discs is always exaggerated in a tooth worn down to the base, and that the anterior discs are wider than the hinder ones. The only accurate method of ascertaining the number of ridges within a given space is to measure the crown, not at the summit, but along the base where the enamel-plates are reflected; the product will then give the average width of each ridge. The skull of the Ceylon Elephant (No. 2656, Coll. Surg.), supplies excellent and readily accessible materials for testing the value of the alleged character, in the so-called *E. Sumatranus*. It contains, above and below, the penultimate and last true molars in action; the former in advanced wear, the latter coming into use, and in the upper jaw barely abraded. The right upper penultimate is worn low, with a loss of the anterior portion. The crown presents the discs of eight distinct ridges, together with a denuded base of ivory in front, corresponding with two ridges that have been worn out. These discs are wide, with highly crimped enamel *machærides*, both being of the *E. Sumatranus* pattern. The following are the principal dimensions:—

Length of crown measured at summit, 8· in. Space occupied by the 7 last discs of wear, 5·8 in. Greatest width of crown, 3·0 in.

In this case the discs are very open, with an average width of about ·83 inches to each; but in the progress of wear, the ridge-plates have become so reclinate, in relation to the plane of detrition, that in the middle of the crown, from the causes above assigned, the grooved enamel-plates are exposed nearly horizontally, to the extent of nine-tenths of an inch. The width of the bands, in this instance, is an exaggeration arising from the obliquity of the section yielding them, in a tooth far advanced in wear.

The last true molar of the same skull makes a different appearance. Although partly extruded it is hardly touched by wear, and the outer wall of the alveolus was removed to expose the concealed hinder portion. The crown is composed of 22 ridge-plates, of which 18 are consolidated, the 4 hindmost being loose. It yields the following dimensions:—

Extreme length, measured diagonally, from apex of front ridge to base of the last ditto, 13· in. Length of ditto, measured along the base of the ridges, 11·5 in. Greatest width, 3·1 in.

Instead, therefore, of ·83 yielded by the penultimate, the ridges in this case give only an average of ·52 inches; and in weighing the result it should be borne in mind that the

three last true molars not only increase successively in the number of their component ridges, but that the latter are proportionally thicker in the older teeth, being an adaptation of nature, to suit the long term of use which the last molars have to serve. Here then are two consecutive molars of the same skull, which, if detached and introduced into a museum without a knowledge of their origin, might be cited—the penultimate as a typical illustration of *E. Sumatranus*, and the last of *E. Indicus*.

Nor is this width of the bands, in worn molars, confined to the Southern Elephant. I have now before me two grinders, picked up by Sir Proby Cautley, in the swamp of Azufghur, a habitual resort of wild Elephants, in the *Terai* of the 'Sàl Forests,' at the foot of the Himalayahs north of Meerut, which present the characters of the discs of wear attributed to the Sumatran Elephant. There is, doubtless, a certain amount of difference to be met with in the teeth of different Elephants living in the same forests; but it is common to the Northern as well as to the Southern form, and as yet there are no good grounds to believe that it ever attains the importance of a specific distinction. The discs of wear in the Ceylon and African Elephants never present a similitude, except when the slightly abraded crown of the latter is confronted with the worn out and *torso* crown of the former.

The most important part of Professor Schlegel's case remains to be considered, namely, the number of the dorsal vertebræ and ribs. Here, also, I find my observations at issue with the conclusions of this distinguished zoologist. He avers not merely that the number of the former differs in the supposed three living species, namely, 21 in the African, 20 in the Sumatran, and 19 in the Indian, but thinks that he has detected a curious inverse relation between these numbers and the thickness of the laminæ of the molars; where the latter are most attenuated the number of dorsal vertebræ is least. If the inference were well founded it would be of high interest. I quote the passage containing it *in extenso*: 'If we take into consideration at once the size of the laminæ of the teeth, in the different species of Elephant, and the number of the ribs and dorsal vertebræ, we obtain the remarkable result, that as the latter numbers decrease the laminæ become narrower. In *E. Africanus* these laminæ are widest, and here we find the greatest number of dorsal vertebræ and pairs of ribs: *E. Sumatranus*, in which the laminæ are narrower, has twenty dorsal vertebræ and pairs of ribs: *E. Indicus*, in which they are still narrower, only nineteen. In the Mammoth, *E. primigenius*, where they are narrowest of all, the number of dorsal vertebræ and ribs appears to be

only eighteen.' [1] Extending the comparison to the Mastodons, and finding that *M. Ohioticus* has only twenty dorsal vertebræ and an equal number of ribs, while its crown-ridges are reduced to three or four, he concludes that the *Mastodons* form not a diverging, but a parallel series with the Elephants. The case, therefore, concerns not merely the Continental and Sumatran varieties of the Indian Elephant, but is a vital question 'pro aris et focis,' affecting the whole of the *Elephantidæ*, fossil and recent. For this reason I must be permitted to examine it in some detail

And first as regards the asserted number in the African Elephant. Professor Schlegel twits Cuvier with having neglected to compare skeletons of the different species of Elephant, and having thus deprived himself of the merit of the discovery of the third living species. Is the reproa well founded? The only skeleton f the African form which existed in the Parisian collections when Cuvier died, and even when De Blainville wrote upon the family in 1844,[2] was that of an adolescent female which lived for some time in the menagerie of Louis the Fourteenth at Versailles.[3] It was imported from Congo; and we have the expressed or implied authority of four most eminent and experienced French comparative anatomists, namely, Daubenton, Cuvier, Laurillard, and De Blainville, that it had only 20 dorsal vertebræ and 20 pairs of ribs. Perrault, who dissected the animal, assigns the same numbers; and the accurate Daubenton, who enumerates the dimensions of all the bones in such minute detail, says—'Il y a vingt vertèbres dorsales, et vingt côtes de chaque côté.'[4] He assigns the following numbers to the different divisions of the column:—7 cervical, 20 dorsal, 3 lumbar, 3 sacral, 31 caudal vertebræ, and 20 pairs of ribs, of which 7 are true and 13 false. Laurillard, as is well known, stood to Cuvier in the same relation of aid as Daubenton did to Buffon, although he never was formally recognized as his collaborateur. When Perrault's skeleton passed into their charge, Cuvier could only state the number which they saw, and finding the dorsal vertebræ to be the same as in the Indian skeletons which he had dissected, namely 20, he naturally assumed that to be the normal number in both the living species, as Peter Camper did on the same grounds.

Skeletons of the African Elephant are very scarce in Eng-

[1] Bijdrage, &c. *Eleph. Sumatranus*; *vide* Translation by Dr. Sclater, 'Natural Hist. Review,' vol. ii. p. 78.

[2] 'Ostéographie:' Éléphants, p. 5.

[3] Perrault, Mémoire pour serv. à l'Hist. des Animaux, 1734, Part iii., Pl. xxiii.

[4] Buffon's 'Hist. Natur.' 4to tom. xi. p. 113.

land. I know of two only, to be found in public collections: the one of an adolescent animal in the Museum of Saffron Walden, mounted, and therefore less reliable; the other in the Osteological department of the British Museum, not set up, and in the most favourable state for examination. It is of a young adult, in which the epiphyses are not yet united, imported from the Cape of Good Hope; sex unrecorded. The bones are still covered with the periosteum and shreds of ligament, having not yet undergone the preliminary operation of cleaning. The vertebral column is in masses of from three to five vertebræ, united by ligaments, while others are free. On three different occasions, specially with a view to the present investigation, has the vertebral column been put together by me, scrupulously examining all the surfaces of juncture from the sacrum to the atlas, and the following results were yielded:—7 cervical v, 20 dorsal v, 3 lumbar v, 4 sacral v, 26-30 caudal vertebræ, and 20 pairs of ribs, one of the last pair being wanting.[1] The precise number of the caudal vertebræ could not be determined, as the terminal portion of them is still embedded in the tail. But there are at the least twenty-six.

We have thus two instances, the one South African and the other from Congo, in which the Elephant of that continent shows only *twenty* dorsal vertebræ. Cuvier is thus relieved from reproach, in so far as this species is concerned.

The skeleton belonging to the Museum at Saffron Walden is that of a young but nearly adult male, which was imported from Algoa Bay.[2] It was carefully examined, with reference to the question now under discussion, jointly by Mr. W. H. Flower and myself, and yielded the following numerical results: cervical vert. 7, dorsal vert. 21, lumbar vert. 3, sacral vert. 3, caudal vert. 30, pairs of ribs 21. The dentition was, at the same time, minutely examined, and I can affirm that the characters agreed exactly with those of the skeleton belonging to the British Museum. The skull and other details of the bony frame were also alike. The evidence is of the more weight, as both skeletons were derived from Southern Africa; excluding the plea which might have been

[1] In order to put the statement beyond question, as resting upon the testimony of a single observer, I requested my friend, Mr W H Flower, the able Conservator of the Museum of the Royal College of Surgeons of England, to examine the skeleton closely, and he arrived at the same numerical results

[2] The Museum at Saffron Walden affords an excellent illustration of what may be done by a small provincial town to promote the cultivation of science. It possesses two mounted skeletons of large Pachyderms, which cannot be matched by any of the Metropolitan collections The museum reflects great credit on the locality.

urged, that they were possibly of distinct species, if they had been procured from different parts of the Continent.[1]

The cases above adduced appear to establish the fact beyond question, that the African Elephant varies in the number of dorsal vertebræ from 20 to 21.

Next, as regards *E. primigenius*, what reliable authority has Prof. Schlegel for the conjectural assertion that the Mammoth had but *eighteen* dorsal vertebræ and ribs? The solitary skeleton,[2] reputed to be nearly perfect, of that species known up to the present time, is the famous Adams-skeleton, preserved at St. Petersburg, and of it there is but one original description extant, namely that of Tilesius, who distinctly states that it possessed *nineteen* dorsal vertebræ and as many ribs: 'Vertebrarum thoracis 19 tantum numeravi, totidemque costas utriusquè lateris, at plurimas e ligno fabrefactas.'[3] If the statement could be trusted it would be conclusive against Prof. Schlegel's argument. But there are errors of observation in the account given by Tilesius, which divest it of authority. He describes the neck as being built up of six cervical vertebræ: 'Collum ex 6 vertebris compressis et coarctatis compositum.' The seventh he appears to have transferred to the dorsal series. In the large and finely engraved figure which he gives of the skeleton, Pl. X., 21 vertebræ are indicated by spinous processes, jointly to the loins and thorax, and 7 to the neck. Allowing three of these to be lumbar, 18 would be dorsal, as conjectured by Professor Schlegel. But grave imputations have recently been cast upon this celebrated skeleton that, like that of the *Mastodon Ohioticus* of the British Museum, it is a make-up derived from more than one individual.[4] Professor Piazzi Smyth

[1] Prof. Schlegel throws out a conjecture, that there may be more than one kind of African Elephant; and in support of it, he refers to two figures of skulls in the 'Ossemens Fossiles,' Plate iv. figs 2 and 10 of vol. i., as indicating differences of length and width; but I believe that they are both of the same cranium; fig. 10 representing the front aspect, drawn to a scale of one-twelfth, and fig. 2, the basal aspect on a scale of one-fifteenth. In the latter, the intermaxillary bones are necessarily foreshortened, from the position in which the skull has been placed, causing a deceptive appearance of short tusk-sheaths.

[2] Of the Mammoth-carcases which, according to the statement of Middendorf, have subsequently been discovered in Siberia, no osteological account, so far as I am aware, has been published. (Bullet. Acad. Petersburg. Class. Phys. iii. p. 150.) The observations of Gleboff refer to the structure of the preserved soft parts. (Bullet. Soc. Imp. Mosc. 1846, xix. pp. 108–134.)

[3] Mém. Acad. Impér. des Scienc. de St. Pétersburg, 1815, tom. v. p. 503.

[4] The mounted 'Koch' skeleton in the National Collection, presents the following vertebræ: 7 cervical, 19 dorsal, 4 lumbar, 3 sacral, and 19 pairs of ribs. It was constructed according to this formula, but the careful observations of Dr. Warren, upon materials of well established authenticity, indicate the following numbers: 7 cervical, 20 dorsal, 3 lumbar, 5 sacral, and 20 pairs of ribs. (Warren, *Op. citat.* p. 25). The lumbar region appears to be built up of bones of different individuals.

examined it, in company with Professor Brandt, and states that the ribs and other parts are restorations made of deal. He sums up his account thus: 'The head, with much of the skin hanging upon it, some cervical vertebræ, a whole fore leg, and more than one foot are, we believe, the genuine Adams-Mammoth.'[1] There is therefore, as yet, no trustworthy evidence to show that the Mammoth had *only* eighteen dorsal vertebræ and ribs; every presumption is in favour of its having had at least nineteen.

Next, as to the number of dorsal vertebræ in the Indian Elephant.—Skeletons, reputed to be Indian, abound everywhere, but strange to say, authentic materials for settling this part of the question are rare, in consequence of the particulars respecting their origin not having been carefully recorded. Until lately, no one doubted that they all belonged to the same species, and the precise locality from which they came was considered to be unimportant.

Prof. Schlegel states that the Sumatran Elephant has constantly 20 dorsal vertebræ and 20 pairs of ribs. That this number does occur in the Ceylon animal also is placed beyond question by the careful dissection of a great anatomist, Peter Camper,[2] and by the observations of Cuvier and De Blainville upon the skeletons of two known Ceylon Elephants brought from Holland to Paris in 1795. The distinguished Dutch zoologist further states, that all the Indian Elephants which he had examined had, without exception, only 19 dorsal vertebræ and 19 pairs of ribs. That this is occasionally or even frequently the case is beyond doubt, from the corroborative evidence of Patrick Blair, Meckel, Warren, and others. For, as remarked by Camper, it is highly improbable that a dorsal vertebra should have disappeared in macerating the bones, preparatory to setting them up. But it is by no means equally certain that the number is constantly limited, in the Indian form, to nineteen. Prof. Schlegel cites the case of the Duvaucel skeleton, forwarded from Bengal to Paris, in which there are twenty dorsal vertebræ.[3] But he tries to get over the difficulty of this exceptional case by the hypothesis that the live animal may

[1] 'Three Cities of Russia,' vol. ii. p. 222. I am indebted to Dr. J. E. Gray for a knowledge of this passage; but there are good grounds to believe that the statement is unintentionally overcharged by an astronomer, giving an opinion on a question of comparative anatomy. For Tilesius, whose account, however defective, shows no signs of partiality to Adams, but the reverse, enumerates the parts that have been restored in wood and gypsum; and, as regards the vertebræ, he writes: 'Vertebræ omnes genuinæ osseæ, ideoque cartilagine exsiccato inter omnem vertebram instructæ, robustiores Elephantinis.' (*Op. citat.* p. 504.) The vertebræ, excepting those of the tail, were less liable to be separated than any other part of the skeleton.

[2] 'Anat. d'un Éléphant Mâle,' p. 63.

[3] Nat. Hist. Review, ii. p. 74.

have been imported from Ceylon into Bengal. I will mention in the sequel the reasons, founded upon many years' residence there, why I consider the assumption to be in the highest degree improbable. It is rare to find the skeleton of an Asiatic Elephant in England, the pedigree of which is so well authenticated as to be beyond conjectures of this kind. But there is one in London, the antecedents of which are well known, being the skeleton of the celebrated male Elephant, '*Choonee*,' preserved in the Museum of the College of Surgeons. The young animal was imported from Bengal in the year 1810, on board the E. I. C. ship 'Astell,' by Captain Hay; [1] and in 1826 it was shot, in the menagerie at Exeter Exchange, in consequence of its violence from sexual excitement. It bore an Indian name, 'Choonee,' and on the occasion of its slaughter it obeyed the word of command to lie down given to it by its English keeper, in the language of Hindostan. All the antecedents are here consistent in proof that the animal was of a Bengal stock. I have examined the skeleton closely, and find that it has 7 cervical, 20 dorsal, 3 lumbar, 4 sacral vertebræ, and 20 pairs of ribs. The last pair have been lost, or omitted in mounting the skeleton. The twentieth dorsal vertebra presents costal articular cups, which are unsymmetrical and small: that on the right side not much exceeding the size of a silver sixpence. But the vertebra is distinctly present. This case, coupled with the Duvaucel skeleton in the 'Jardin des Plantes,' seems to establish, without searching for others, that the Continental Elephant of Northern India varies in the number of its dorsal vertebræ from 19 to 20, as the African varies from 20 to 21.[2]

The hypothesis entertained by Professor Schlegel, upon the statement of Diard, that Ceylon Elephants are frequently imported into Bengal is, I am satisfied, untenable. Under the pressure of the Great Mutiny of 1858, the Indian Government brought Elephants by sea from Pegu and the adjoining Tenasserim provinces to Calcutta, but none from Ceylon. The occurrence up to that time was so rare there that the

[1] Griffith's 'Animal Kingdom,' vol. iii. p. 348; and Hone's 'Every-Day Book. &c.' Vol. ii. p. 322.

[2] The ingenious view advanced by Prof. Schlegel regarding the inverse relation between the number of *laminæ* in the molars and the number of dorsal vertebræ in the different species (*supra*, p. 263), does not appear to be tenable against the evidence adduced above, of the numerical variability in the living species. Nor can I assent to the inference founded upon it, that the 'Mastodons form not a diverging, but a parallel series with the Elephants.' The Indian fossil species, which have been ranged under the designation of *Stegodon*, establish, through their molar teeth, a manifest and nearly unbroken passage from the Mastodons into the true Elephants. [*Vide* Quart. Journ. Geol. Society, 1857, vol. xiii. p. 314, and *antea*, pp. 9 and 82. —ED.]

debarcation of the animals, slung through the air, was figured in the 'Illustrated London News' of the day as a remarkable event. Young Elephants are, I believe, never imported from Ceylon to Calcutta;[1] and 'Choonee' was exported thence as a very young animal. Ceylon Elephants are exported to the adjoining peninsula; but they are commonly reserved for the priests of the pagodas, for the chiefs of Southern India, and for the commissariat demands of the Madras and Bombay Presidencies. I doubt if the Ceylon Elephant could endure the winter cold of the North-Western provinces, exposed in the open air. I have been on the back of an indigenous Elephant, in the valley of Deyra, in the North-Western provinces, which is constantly resorted to by herds of the wild animal, when the thermometer stood before sunrise at 22° Fahr.; and Sir Andrew Waugh informs me that during the measurement of the base-line for the Trigonometrical Survey, in Chuch, the temperature fell to 15° Fahr., with Elephants in the camp, exposed to the open air.

On a review, therefore, of the whole case, the evidence in every aspect appears to fail in showing that the Elephant of Ceylon and Sumatra is of a species distinct from the Continental Indian form. Having had opportunities of observing the animal along a range of habitat, which rarely fall to the lot of a single naturalist, I have felt called upon to express an opinion on the moot question. These embraced a residence during many years at Suharunpoor, in lat. 30°, near the extreme northern range of the species, close to jungles where wild Elephants abound, and which my duties led me frequently to explore. In 1832, I was present at the 'Koom,' or great Religious Fair, which takes place at Hurdwar, on the Ganges, after each cycle of twelve years.[2] Vast multitudes of devotees, and others of all ranks and castes and of both sexes assemble there from the most remote parts of India and the surrounding countries, all the wealthiest classes bringing Elephants with them.[3] On that occasion I

[1] Mr. Blyth, in a late number of the 'Journal of the Asiatic Society of Bengal,' received since the above remarks were made, confirms the statement. By a return received from the Military Commissariat Office, at Calcutta, it appears that 826 Elephants were imported there, from Moulmein and Rangoon, in the years 1857 to 1859. 'No Elephants,' it is added, 'were received at Calcutta from Ceylon.' A communication from Col. Phayre mentions that in the seventeen months, from Dec. 1857 to April 1859, no fewer than 1,034 Elephants were shipped from the same ports to Madras and Bengal, showing the vast number of Elephants occurring in the forests of the Trans-Gangetic provinces, and the adjoining districts of Siam. (*Op. cit.* 1862, No. ii. p. 174.)

[2] 'Kumbha Mela.' Duodecennial, when Jupiter is in *Aquarius*, and the sun entering into *Aries*. (*Vide* Raper. Asiat. Research. Vol. xi. p. 456.)

[3] General Hardwick, who was present at the 'Koom' Fair of 1796, estimates the number of human beings then assembled to have exceeded two and a half millions! doubtless an exaggeration. Five hundred devotees of one sect were

endeavoured, through the native officers connected with the administration of the Fair, to ascertain the number of Elephants then crowded within a small area, and the return made was about eleven hundred, derived from all parts of India, the majority of which passed under my eye. I have seen the Elephants of Pegu and Siam in the forests of the Tenasserim provinces, and the Ceylon Elephant in its native island. The only geographical forms of the Asiatic species which I have not examined alive are those of Cochin-China, Borneo, and Sumatra. The result of this range of observation, combined with long osteological study, has been to establish the conviction in my mind that there is but a single species of Asiatic Elephant at present known, modified, doubtless, according to his more northern or southern habitat, but not to an extent exceeding that of a slight geographical variety.

It is the more necessary that the subject should be thoroughly investigated, since upon the hasty assumption that the Elephants of Ceylon and Sumatra belong to a distinct species, a speculation has been put forward which seeks to explain it by means of a former direct continuity of land between the two islands.[1] But the inferences of physical geography and of geology are alike opposed to the conjecture. The range of low hills which forms the spine of the Malay Peninsula, and which is separated by a narrow interval only from the Islands of the Archipelago, can be traced north, increasing in height and development till it joins on with the Himalayahs; while Ceylon, as has often been remarked, presents all the physical characters of being a severed portion of the distinct mountain-system of the Western Ghats. With certain exceptions, the Mammalian fauna, as a general rule, confirms this view, as do also recent investigations on the Flora of the mountainous regions of the adjoining Indian Peninsula, near its extremity. That a connection formerly, and at no very remote epoch, existed between the Malay Archipelago and the continuous main land, is clearly indicated by the species of the large Mammalia common to both, including *Rhinoceros Sumatranus*, *R. Sondaicus*, *Bos Sondaicus*,

killed in an affray by the Sikhs I do not vouch for the accuracy of the number of Elephants reported to me, on the occasion above referred to, but I believe it to have been under the truth, rather than above it I mention this, the more especially, as probably no such assemblage of Elephants will ever again be seen at Hurdwar. The facilities of railway travelling will relieve the Princes of Southern India, such as Travancore and Tanjore, &c., from the necessity of taking a cortège of Elephants with them, when they attend the Koom Fair in future. (Hardwick, *Op. cit.* vol vi. p. 312) During the 'Koom' of 1760, eighteen thousand Bairagis (Fakirs of one sect) are said to have been slaughtered by the Gosains, another sect. (*Op. cit.* vol. xi. p. 455.)

[1] Tennent. 'Nat. History of Ceylon,' 1861, pp 61-67.

Tapirus Malayanus, Styloceros Muntjac, Nœmorhœdus Sumatrensis, Ursus Malayanus, &c., the majority of which range as far north as Pegu, or further.[1] That the Indian Elephant should have participated in the same common range is thus relieved from any plea of improbability; while the speculation that Sumatra was in direct continuity with Ceylon within the period of the existing fauna is beset with insurmountable difficulties. In the view here taken it is also needless, since the species may have spread southwards from a common centre, on both sides of the Bay of Bengal, and on its eastern shore into the promontory which formerly forked the Indian Ocean. The speculation here controverted appears to rest upon grounds as fallacious as those which led De Blainville, mainly upon spurious Proboscidean evidence, to conjecture that Australia was formerly a dependency of the American continent.[2]

§ 10. Asserted Occurrence of Mastodon in Australia.

Next to the *Equidæ*, the Proboscideans are among the most cosmopolitan and widely distributed of Ungulate Mammalia. *Dinotherium* occurs alike in the Miocene deposits of India and Europe; while species of Mastodon and Elephant, extinct or living, have been found over the whole surface of Europe, Asia, and Africa, and in both divisions of the American Continent. On the other hand, as has often been remarked before, Australia has a living fauna, so low and backward in the scale of organization, that it has struck those who have reflected on it in the light of being an arrested fragment of an older world, in which progress was suspended, whilst in the other continents it was being steadily sustained by the appearance of higher and higher forms. With the exception of the Dingo, which is believed to have accompanied man,[3] and of a certain number of indigenous Rats, the existing mammalian fauna of Australia is exclusively restricted to marsupial forms. The extinct fauna, which has been so ably investigated by Professor Owen, so far as it goes, bears the same character. The

[1] Cantor, 'Journ. Asiat. Soc. of Bengal,' 1846, vol. xv. p. 275.

[2] Ostéographie: 'Dinotherium:' 50.

[3] Prof. McCoy, in a recent comparison between the ancient and modern natural history of Victoria, states that he had identified remains of the *Canis Dingo* in the bone-caverns lately opened beneath the basalt-flows at Mount Macedon. They were found associated with those of *Macropus Titan*, and of recent species of *Hypsiprymnus* and *Hydromys*. He infers from this and other arguments that the *Dingo* is an indigenous animal. But there is no evidence that man may not have then been an inhabitant of Australia, and the *Dingo* introduced along with him. The latter still stands out, a symbol of isolation (Annals and Mag. of Nat. Hist. 1862, 3d Ser. vol. ix. pp. 145, 147).

colossal *Diprotodon* and *Nototherium*, with the carnivorous *Thylacoleo*, have died out, and the giant Kangaroos, &c., have dwindled down into their small-sized living representatives. But except in bulk and in the extinction of certain types, there is no indication that the modern fauna has degenerated from a higher to a lower grade of organization. To this general rule there is only one asserted exception, which, however, is of a very important order, being the so-called *Mastodon Australis* of Prof. Owen. I have long entertained doubts regarding the authenticity of the solitary molar tooth, upon which the conclusion mainly rests. These I have already advanced in an abridged form;[1] but as the assertion has since then been repeated by its author, it is full time that the case should be either established or confuted, more especially as the asserted exception, coming forth under the authority of so eminent a name, has been commonly adopted by palæontologists.

In 1843 Professor Owen published the description and figure of a fossil femur of large size, discovered by Sir Thomas L. Mitchell in Darling Downs, SW. of Moreton Bay, in Australia.[2] It was compared with the corresponding bone of *Mastodon giganteus*, and inferred to be of a Mastodontoid quadruped. But a perfect femur of *Diprotodon Australis*, acquired within the last few years for the British Museum, along with an entire cranium and other fine remains, places it beyond doubt that the Darling Downs specimen, now preserved in the Museum of the College of Surgeons, is of the Marsupial *Diprotodon*, and not of any Proboscidean form.

In the following year (1844), the same author published a figure and description of 'a fossil molar tooth of a Mastodon discovered by Count Strzlecki in Australia,' which he provisionally named *M. Australis*; and he describes it as bearing a close resemblance to the molars of *M. angustidens* of Europe.[3] In his report 'On the Fossil Mammalia of Australia,' communicated to the British Association in 1844, the following paragraph occurs:

'I cannot conclude, without adverting to the singular exception which the Mastodon forms to the continental localization, not only of existing but of Pliocene and Post-Pliocene extinct genera of mammalia above briefly dwelt upon. The solitary character of the exception helps rather to establish the generalization, at least I know of no other extinct genus of mammal which was so cosmopolitan as the Mastodon. It

[1] Quarterly Journ. Geo. Soc. vol. xiii. p. 319, Synop. Table. [See also vol. i. p. 106.—Ed.]

[2] Annals and Mag. of Nat. History, New Ser. vol. xi. p. 8, fig. 1.

[3] *Op. cit.* vol. xiv. p. 268.

was represented by species for the most part very closely allied, if actually distinct, in Europe, in Asia, in North and South America, and in Australia; it is the only aboriginal genus of quadruped in that continent which was represented by other species in other parts of the world.'[1] Here is an exception, the importance of which, if sound, can hardly be overrated, in reference to the laws which governed the distribution of the extinct mammalia of the Australian continent. The identification upon which it rests has not yet been withdrawn, so far as I am aware, by the author; and in his inaugural address to the British Association at Leeds, he re-affirms it twice, in the remarks upon the geographical distribution of animals.[2] As Professor Owen has not published others, it is presumed that the evidences there referred to are derived either from the remains received from Sir T. L. Mitchell, or from the molar tooth brought by Count Strzlecki. The former being of Diprotodon, the *onus probandi* now rests with the latter, which, also, is preserved in the Museum of the College of Surgeons. The specimen consists of a very perfect and intact germ of a back molar. The enamel-shell is completely formed, but the pulp-nucleus had only been partially calcified, so that the ivory is limited to a thin layer below the enamel, upon which the re-entering angles of the transverse ridges are distinctly visible underneath. No part of the ivory base, or fangs, had been formed, nor is any trace of cement visible upon the crown-surface. The specimen is entire, with the exception of a slight fracture at the top of the inner tubercle of the front ridge, which is decurrent to the base in a vertical fissure of old date, being filled up with matrix. The tooth is the penultimate true molar (m. 2) of the lower jaw, left side; the crown is composed of three very distinct transverse ridges, divided in the longitudinal direction by a distinct bipartient fissure into an outer and inner division, each composed of a pair of high and obtusely conical thick points. The outer division of each ridge throws out, both in front and behind, a solitary outlying tubercle, attaining a lower elevation than the principal points. These tubercles of the contiguous ridges are connate, so as to form a bridge connecting each outer pair of mammillæ and block-

[1] British Association Report, 1844, pp. 223, 239.

[2] 'I have received evidences of Elephantine species from China and Australia, proving the Proboscidean Pachyderms to have been the most cosmopolitan of hoofed quadrupeds.' (Brit. Assoc. Report, 1858, *Address*, p. lxxxvi.) 'In the formation of these recent tertiary periods, and in the limestone caverns of Australia, abundance of Mammalian fossils have been found, and, with the exception of the single tooth of a Mastodon, every one of them has proved to be marsupial species.' (*Idem*, p. lxxxviii.)

ing up that part of the valley which lies between them, while the inner pair of points, belonging to each ridge, is free from accessory tubercles, thus leaving the portion of the divided valleys between the inner points open. A small anterior talon, running outwards, descends around the base of the outer tubercle of the front ridge, and a larger posterior talon, composed of two or three tubercles, is appended to the posterior end of the outer division of the last ridge, but free from any connection with the inner division of the same ridge. The tooth, therefore, belongs to the sub-genus *Trilophodon*, and to that section of it which may be characterized by '*Colliculi obtusi, valliculæ interruptæ.*' The necessary consequence of the form of the crown, as above described, is that in the progress of wear, when the ridges are ground down, the outer pair of points with its outlying appendages must yield a trefoil or complex pattern to the disc of abrasion; while the inner pair, being simple, would yield an elliptical and transverse disc, free from any complication. This is the character which distinguishes *Mastodon Andium* from *Mastodon Humboldtii*. As these species are but imperfectly known in England, and one of them still more imperfectly represented by specimens, a few remarks upon them may not be considered out of place on the present occasion. Although these names were vaguely imposed by Cuvier, we are indebted to Laurillard [1] for the first accurate definition of their distinctive characters, which has been confirmed by Gervais, from the fine series of remains brought by Weddell from Bolivia.[2] Both belong to the subgenus *Trilophodon*. In *M. Humboldtii*, both the inner and the outer divisions of each ridge are flanked by outlying tubercles, so that the valleys are blocked up, and the mammillæ being channelled vertically, a very complex pattern is yielded by the discs of wear; two trefoils are produced, separated by a cleft, somewhat as in the molars of *Hippopotamus*, or, as it has been happily expressed by Gervais, 'Deux figures en trèfle adossées par leur base.' [3] The valleys are covered with a thick coat of cement, and the lower jaw is destitute of an incisive beak. In *M. Andium* there is but a single trefoil, accompanied by an elliptical transverse disc to each ridge, the valleys are sparingly invested with cement, and the symphysis of the lower jaw is produced into a long massive and deflected incisive beak, as in *Mastodon angustidens*. This beak, as shown by the young animal, is figured by Laurillard in d'Orbigny's 'Voyage;' and I have seen at Geneva the cast

[1] Alcide d'Orbigny's 'Voyage dans l'Amér Méridion.,' Géol. p. 144, Pls. x. and xi.; and Dict. Univers. d'Hist. Natur. tom. viii. p. 30.

[2] 'Recherch. sur les Mammifères Fossiles de l'Amérique Méridionale.' Expédition de Castelnau, 1855, p. 14, Pl. v.

[3] *Op. cit.* p. 18.

of it, as presented by the adult animal. The specimen was brought by M. H. de Saussure from Mexico (*antea*, p. 226), and the beak in this case bore the base of a very large incisor on one side.[1] *Mastodon Humboldtii* is found in Colombia, Buenos Ayres, and Brazil: *M. Andium*, chiefly in Chili, Bolivia, and Peru; the valley of Tarija, in particular, abounds in remains of this species. The reputed Australian molar agrees so closely with specimens of *M. Andium*, brought by Weddell from Tarija, which I have studied in the Palæontological Gallery of the Jardin des Plantes at Paris, that I have failed to detect any sufficient character by which to distinguish them.[2] They agree also in mineral condition, and in the dark brown glossy colour of the enamel, where denuded of matrix.

As regards the history of the reputed Australian specimen, unfortunately it was not seen *in situ* by Count Strzlecki. That enterprising traveller, whose explorations embraced North and South America, Australia, the Javanese Islands, &c., states that he 'bought it from a native at Boree, the sheep-station of Captain Ryan, through the agency of the overseer of that station. The native, in giving the bone, stated that similar ones, and larger still, might be got further in the interior; but that, owing to the hostility of a tribe upon whose grounds the bones are found, it was impossible for him to venture in that time in search for more,' &c.[3] The account given in Professor Owen's paper differs in some respects: being to the effect, that the specimen was brought by a native to Count Strzlecki when exploring the ossiferous caves of Wellington Valley;[4] and that the native

[1] Laurillard inferred from d'Orbigny's figure, that, although the beak was elongated, from its tenuity there were no incisors to the lower jaw in this instance; or that, if ever present, they were rudimentary, and had been shed early in life. In the specimen figured by Dr. Wyman, showing the lower jaw of an adolescent animal, the symphysis is somewhat elongated, but blunt, and there is no appearance of its having held incisors. The possession of mandibular incisors may have been a sexual distinction. (United States' Australian Expedition, Pl. xii. figs. 1 and 2.)

[2] On the occasion where I first questioned the authenticity of the reputed Australian Mastodon, I was led to identify it with *M. Humboldtii*, instead of *M. Andium* (*vide* Quart. Journ. Geol. Soc. 1857, vol. xiii. Synoptical table, p. 319*). On the same occasion (*op. cit.* p. 313†) I called attention to the exceptional character of certain specimens of *M. Andium*, as if hesitating between *Tetralophodon* and *Trilophodon*. I believe the species will prove to belong to the latter group. [As early as 1846, Dr. F. pointed out that the tooth of the so-called *Mastodon Australis* did 'not furnish characters sufficient to distinguish it from *M. Andium*.' See vol. i. p. 106.—Ed.]

[3] Strzlecki, 'Physical Description of New South Wales,' &c., 1845, p. 312.

[4] Boree Creek, an affluent of the Lachlan River, is in the Ashburnham District, north of Canobalas Mountain; while Wellington Valley is on the Macquarie River, an affluent of the Darling. A considerable tract intervenes.

* *Antea*, p. 14.—[Ed.]

† *Antea*, p. 8, note 2.—[Ed.]

stated that it was taken out of a cave further in the interior.[1] But the fossil bones of the ossiferous breccias of that valley are covered with a bright coloured ochreous clay, not a trace of which is to be seen on the fossil molar, the matrix of which is of an entirely different character. Settlements have been pushed into the interior since 1843, far beyond Boree and Wellington Valley; while the country has been penetrated in various directions by exploratory expeditions. Stupendous remains of *Diprotodon* and *Nototherium*, in the finest state of preservation, have been discovered, and remains also of the very remarkable form named *Thylacoleo*; but during the twenty years which have lapsed, not a trace has been detected, so far at least as published accounts go, of anything confirming the inference of an Australian Mastodon. Where remains of the Proboscidea occur they are commonly found in abundance; and the colossal size of the bones has led, in all ages and in all countries, to their attracting lively attention. The absence of direct testimony in the first instance, the conflicting statements regarding the place and conditions of occurrence, the discordance of the matrix, and the failure of subsequent confirmatory evidence, coupled with the fact of the solitary molar having been identified as being of a South American species, lay the authenticity of the specimen open to grave doubts. If an American form, how did this unique morceau get to Australia?[2] If Australian, how has the *Mastodon* alone, of all the higher placental mammals, broken through the barriers of marsupial isolation, characteristic of the great southern island? Of the alternatives, there are probably few palæontologists who will be disposed to seek for an explanation in the naive conjecture of De Blainville, that Australia, to meet the requirements of the case, was in connection with America within the Pliocene period.[3] It seems more probable that some unintentional error has got mixed up with the history of this remarkable fossil; and until further confirmatory evidence is adduced, of an unimpeachable character, faith cannot be reposed in the reality of the asserted Australian Mastodon.[4]

[1] 'It is partially mineralized and coated with the reddish ferruginous earth, characteristic of the Australian fossils discovered in the Wellington ossiferous caves by Sir T. Mitchell.' (Annals and Mag. of Nat. Hist., vol. xiv. p. 270.)

[2] Prof. Morris authorizes me to say, that when examining the Palæozoic fossils, brought home by Count Strzlecki, from Australia, of which he gave an account, he found certain specimens accidentally mixed up with a series which he suggested could not have been obtained from the same locality, and on his remonstrance to this effect, Count Strzlecki assented to their omission from the described list. Prof. Morris suggested that the exceptional specimens were probably of South-American origin.

[3] The fact that such a hypothesis was advanced shows the responsibility involved in the publication of the *data* which gave rise to it.

[4] Since the above remarks were written Professor Owen again brought forward

§ XI. Food of Living and Extinct Elephants.

The alimentary habits of the Asiatic Elephant, in the wild and subjugated state, have been so carefully observed, that there is, perhaps, no other pachyderm with which, in this respect, we are better acquainted. But the same cannot be said of the African species; the details of the vegetable matters which constitute his staple food are only known in a very general way, although it is certain, from the difference of the vegetation of Southern Africa, where he now exists in great force, and of Northern and Western Africa, near the foot of the Atlas, where he abounded within the historical period, that his food must vary within a considerable range of species. The teeth of the Asiatic and African Elephants are so differently modified, and the trees on which they browse are so distinct, that the Asiatic species would probably be distressed for food, where the African finds it in abundance, and *vice versâ*. Both are represented in the fossil state by species having molars constructed more or less after the patterns respectively yielded by them, and I propose to consider how far our knowledge of the former will assist us in speculating regarding the alimentary habits of the latter.

(*a.*) *Food of the Indian Elephant.*—The 'Sàl,' or 'Tarai' Forests, which stretch at the foot of the Himalayahs, from lat. 30°, where the Ganges and Jumna escape from the mountains, to the Brahmapootra, embracing a range of several hundred miles, are here selected to furnish the chief illustrations which I have to adduce. They everywhere abound with Elephants, southwards from lat. 30°, which may be regarded as the extreme northern limit of the habitat of the species at the present day. Forests presenting similar physical characters extend along the continuation of the same range, through Sylhet, Chittagong, Arracan, Pegu, and the Tenasserim provinces, to the point of the Malay Peninsula; they become more and more tropical in their vegetation, and, as a general rule, the Elephants improve in size, form, and vigour, according to their more southern habitat.

The Sàl Forests are densely covered with arboreous forms belonging chiefly to the following Dicotyledonous genera:—

the case of the Australian *Mastodon*, as a proof of the remarkable geographical distribution of the Proboscidea, in a communication which he delivered to the British Association at Cambridge, on Oct. 4, entitled, 'On a tooth of *Mastodon* from the Tertiary marls near Shanghai.' In the subsequent discussion, he frankly abandoned it, in consequence of the doubts then urged regarding its authenticity. As the asserted fact has taken deep root in systematic works, it is still necessary that the refutation here embodied should appear in the records of Science. (*Vide* 'Parthenon,' Oct. 11, 1862, p. 754.)

Vatica, Pentaptera, Terminalia, Conocarpus, Casearia, Dalbergia, Cedrela, Buchannania, Semecarpus, Boswellia, Spondias, Odina, Garruga, Cathartocarpus, Bauhinia, Butea, Erythrina, Acacia, Robinia, Moringa, Kydia, Sterculia, Bombax, Grewia, Murraya, Glycosmis, Citrus, Nauclea, Hymenodictyon, Rondeletia, Schrebera, Eugenia, Careya, Ulmus, Gmelina, Premna, Emblica, Röttlera, Briedelia, Ehretia, Tetranthera, Cordia, Wrightia, Holarrhena, Antidesma, Putranjiva, Trophis, Cochlospermum, Batis, Diospyros, Bassia, Morus, Ficus, &c.

But of the large number of species belonging to these genera, a very small percentage only of the aggregate mass of forms enters into the food of the Indian Elephant; the reason of this being, that some of the species, such as the 'Sàl' (*Vatica robusta*) and other predominating trees, which extend for miles nearly to the exclusion of other trees, contribute nothing to the aliment of the animal. In fact, the range of his arboreous selection is restricted within a narrow circle, and mainly to the foliage and branches of trees that abound in milky juice which is not acrid, belonging to the families of the *Moreæ, Artocarpea*, and *Sapotaceæ*, such as species of *Ficus, Batis, Artocarpus, Bassia*, and *Mimusops*.[1] Of these, by far the greater part of his staple food is derived from the colossal fig-trees which abound in the forests of India; such as *Ficus Indica*, the 'Bur,' or Banyan-tree; *F. religiosa*, 'Peepul,' or 'Bodhi-drooma' (Tree of knowledge); *F. venosa*, 'Pilkhun'; *F. cordifolia*, 'Gujeena,' or 'Assoud'; *F. glomerata*, 'Goolur'; *F. Tsiela*, 'Kuth-bur'; and in Assam, *Ficus elastica*, or the 'India-rubber tree,' besides other more southern species of similar habit and properties. The strong partiality of the Elephant for these trees is so well known to the natives, that the '*Obees*,' or Pit-falls, for entrapping the animal are invariably constructed in their neighbourhood, and many of their old Sanscrit names connect them specially with the Elephant.[2] He tears down their branches, and crunches the twigs and leaves, stripping off the lactiferous bark of the larger boughs. The Elephant of the 'Sàl' Forests also derives occasional food from the foliage and fruit of *Artocarpus Lakoocha*, 'Dhao'; *Batis aurantiaca*, 'Puneeala'; *Bassia latifolia*, 'Muhowa'; and among others from the fruit of *Feronia Elephantum*, 'Kuth-bel'; *Ægle marmelos*, 'Bael'; *Diospyros tomentosa*, 'Teindoo'; and in the Southern forests, from the huge induviated fruits of certain species of *Dillenia*, &c. Of aliment derived from the roots of

[1] Also *Mesua ferrea* (Nat Ord. *Clusiaceæ*), on the authority of Tennent's Nat. Hist of Ceylon, p. 230

[2] 'Nagbhundoo,' 'Koonjurashun', 'Gujashun,' and 'Gujbhukshuk'; all being to the effect of 'food of Elephants.' (*Vide* Madden, Journ. Asiat. Soc. Beng., vol. xvii. p. 380.)

Dicotyledonous trees and shrubs, such as the African Elephant is said to affect, I know of but one form in the 'Sàl Forests' which the Indian species is known to touch, namely, the huge tuberous dilatation of the ligneous root of the Scandent, *Pueraria tuberosa*, 'Sural.' The fruticose and herbaceous Dicotyledons, the foliage and stems of which may enter into his occasional food, I do not attempt to enumerate.

Among the monocotyledonous families, a very large portion of his habitual fare is derived from the *Gramineæ*, and more sparingly from Palms; of the former, he luxuriates on the young shoots and tender foliage of various species of Bamboo, which occur in vast abundance, together with the fleshy albuminous fruit of *Beesha Rheedii*, found in the southern forests. The 'jhils,' or swamps, to which he resorts, are sheeted with the gigantic reeds of *Arundo kurka*, 'Nul,' the young culms of which, together with the stems and leaves of *Typha Elephantina*, 'Patela,' at certain seasons, constitute a favourite food of the Indian Elephant. The open glades and prairie lands are covered with species of *Saccharum*, forming what is called 'Grass Jungle,' composed chiefly of *S. spontaneum*, 'Kas,' interspersed with *S. fuscum*, 'Tat,' *S. Sara*, '*Surkura*,' or 'Moonj,' *S. exaltatum*, 'Suroo,' &c. Clumps of these grasses are twisted up by his trunk, in his journeys to and from the forests; they are beaten against his legs to free the roots from sand, and then subjected to mastication. The sand which still adheres to these grasses, together with the large quantity of silica contained in the leaves and culms of *Saccharum spontaneum*, the most characteristic species of the grass jungle, performs an important duty in the economy of wear of the Elephant's molar teeth.[1] Palms, which are stated to occupy the first rank in the favourite food of the animals in Ceylon,[2] are represented in the 'Sàl' Forests by species which either do not, or hardly at all contribute to it: being limited to *Calamus Roylei*, *Phœnix acaulis*, and *Harina oblongifolia*. But in the more southern forests they are replaced by various genera and species, the tender and farinaceous leading shoot of which, as in Ceylon, is eagerly eaten by the Elephant. But compared with the wild fig-trees, bamboos, and other grasses, they constitute a subordinate part only of the food of the wild animal. When he makes a raid into cultivated tracts

[1] The excessive abundance of silica in the culms and leaves of *S. spontaneum* is practically shown when it is attempted to mow it with an English scythe. After a few sweeps, the edge of the implement is rounded off, as I have repeatedly witnessed.

[2] Tennent, Nat. Hist. of Ceylon, p. 230.

he commits great havoc upon sugar cane, rice fields, plantains, and many other cultivated plants;[1] but these incidents form only interludes in his established alimentary habits. His dung in the wild state commonly presents a large proportion of contused and undigested woody fibre, in a stringy form, mixed up with other vegetable tissues.

It is difficult to conceive of a mechanism better adapted to the duty which they have to perform than is presented by the molars of the Indian Elephant. Taking the three true molars, which serve during the adult stage of the animal, they are composed successively of 12, 16, and 24 ridges. Each ridge has the core formed of a high wedge-shaped plate of ivory; a continuous plate of enamel is closely folded over these wedges, which are confluent at their base; and the intervals between the ridges are filled up, each with a reversed wedge of cement, which is insinuated between the grooves and inequalities of the enamel. When the crown is in full activity of wear, the penultimate molar, consisting of sixteen ridges, presents an unequal triturating surface, composed of thirty-two plates of enamel, alternating with sixteen thin wedges of ivory and as many of cement, making in all sixty-four alternations, disposed within a length of from $8\frac{1}{2}$ to $9\frac{1}{2}$ inches. The disintegrating and bruising power of the surface is further greatly augmented by the circumstance, that in the Asiatic Elephant the plates of enamel are folded vertically into a number of bold close-set zig-zags, or undulations, which present a crimped edge during wear. If a number of these plates were brought together, so as to place their undulations in contact, an appearance would be produced analogous on a large scale to the engine-turning of a watch-case, arranged in longitudinal lines. The three constituent materials being of unequal hardness, the cement is worn lowest, the enamel highest, and the ivory to a level between the two. A constant equilibrium is maintained, in the normal state, between the nature of the food, the waste of the crown-surface, the absorption of the fangs, the forward movement of the body of the tooth, and the replacement of the worn-out portion by a succession of fresh plates, protruded from behind.

This goes on in the wild state, but no sooner is the animal kept in captivity than the balance is upset, and the whole mechanism put out of gear. Instead of grass culms and leaves charged with silicious crystals, or mechanically mixed with sand, and of tough woody fibre and bark, requiring a powerful process of trituration to fit them for deglutition,

[1] Corse, Asiat. Researches, vol. III. p. 229.

the animal is supplied with concentrated cereal food and hay, with an admixture of nutritious roots and mashes, or green fodder. The consequence is, that the crowns of the active molars do not get worn down with sufficient rapidity to make way for the tooth forming behind, and abnormal or morbid results follow:—

1st. The used surface of the crown, instead of being unequal and terraced, is worn smooth and flat, in some instances even like a slab of polished marble.

2nd. The uncalcified back portion of the capsule of the tooth in action, instead of remaining distinct, becomes, from the undue pressure behind, united with the formative capsule of the contiguous back tooth, the development of which is not retarded, and the two separate molars are fused into one unwieldy mass, covered by a continuous shell of cement. A fine example of this state is presented by an adolescent cranium in the Museum of the College of Surgeons (No. 2665, Osteol. Cat.), in which two molars and apparently part of the third in front are united into one; and the pressure has, besides, acted so as to contract the palate, and bring the opposite molars nearly into contact in front.

3rd. The anterior fangs of the tooth in action are gradually absorbed while the corresponding portion of the crown remains unworn and is projected forwards, like a foreign body, beyond the edge of the alveolus. I observed a very remarkable instance of this morbid condition in the cranium of a 'Mukna' Elephant, preserved in the Natural History Museum at Florence. On the right side, in this specimen, there are three molars *in situ*: the last in germ, the penultimate partly worn, and agglutinated to it in front the extruded body, without fangs, of the antepenultimate, which is projected forwards and upwards across the diastemal interval, so as actually to press against the palatine floor of the maxillary bones. In this case the morbid pressure had caused the absorption of the plate of bone forming the base of the sheath of the incisor, which is indicated by a deep pit, and it probably led to the death of the animal, with great torture.

4th. The capsule of the last molar being constrained for room, by the undue resistance in front of it, there is not sufficient space for the normal arrangement of all the plates as they are successively calcified, and the hindermost become distorted in position. A fine example of this malformation is presented by the last lower molar, fig. 90, of the 'British Fossil Mammalia.'[1] The tooth is there described as being

[1] *Op. cit.* pp. 226 and 233, and Cat. Foss. Mam. &c. Coll. of Sur. No. 567, p. 134. It is the more necessary to make the rectification here indicated, since the figure has been copied by an eminent French Palæontologist, on the

of the Mammoth, but it is in reality a molar, disguised and blackened by smoke, of an Asiatic Elephant which had died in captivity. The back plates, in this case, are pressed and crowded upwards so as to have become nearly horizontal. Similar instances are figured by De Blainville,[1] without his having been aware of the nature and cause of the distortion.

The Elephants kept in the menageries in Europe are all, more or less, in this morbid condition of the dental system. They are fed on rations composed largely of turnips, carrots, mangold-wurzel, and of mashes of boiled rice, bran, sea-biscuit, and chaff, &c. The only hard and dry food issued to them consists of a truss or two of hay, and the straw used for their litter. Ligneous food, such as they partly live upon in the wild state, is denied to them, and the results are so certain, that one can anywhere point out in a museum the molar of an Elephant which has been kept in captivity. For obvious reasons, the effects, although still discernible, are less pronounced in the molars of Elephants which have been retained in bondage in their native country.

The bearing of these observations upon the normal condition of teeth of the Mammoth, and its inferred alimentary habits, will be shown in the sequel.

(*b.*) *Food of the African Elephant.*—The alimentary habits of the Indian species are so well known, simply from the fact, that being tamed one can observe from his back, in beating through his native jungles, everything which he selects and all that he passes by. The same close observation cannot be applied to the African form, as at the present day he is nowhere in his native continent trained for the use of man. Our knowledge of his food is, therefore, of a vague and general character, being derived from the cursory observation of travellers, whose attention was not specially directed to the subject.

The molar teeth of the African Elephant are intermediate, in construction and triturating characters, between those of the *Euelephantes*, or Elephants proper, and the fossil *Stegodons*. They present, in the three intermediate and last molars for the ridge-formula, the successive ciphers 7 : 7, 8, 10; while *E. antiquus* presents the ciphers 10 : 10, 12, 16, and *E. primigenius* and *E. Indicus*, 12 : 12, 16, 24. The aggregate of the series of ridges in the first amounts only to 32; in the second to 48; and in the two last to 64; involving a great difference in the triturating mechanism of the teeth. In the African form the molars are also shorter, narrower,

authority of the work, as a characteristic specimen of *E. primigenius*. (*Vide* Mémoires Acad. Montpell., tom. i. p. 423, Pl. xv. fig. 9.)

[1] Ostéographie: Éléphant, Pl. vii. fig. 6, and Pl. x. fig. 6.

and of less elevation, than in the Asiatic species. The discs of wear, instead of the narrow transverse bands seen in the latter, exhibit the well-known rhomboidal expansion characteristic of the species. Instead, therefore, of being adapted to contuse and triturate the branches and twigs of trees, they are better suited for squeezing and crushing leaves, and succulent stems or roots. The habits of the animal, as observed by travellers, are in accordance with these indications. Besides browsing on the foliage of the Mimosas and Acacias, which abound in Southern Africa, they tear up the trees of certain species of these genera by the roots, aided, according to Pringle, by their tusk, used as a crow-bar (?), and they devour the succulent parts of these roots in the inverted trees.[1] Burchell mentions a small species of *Prosopis*, *P. Elephantorhiza*, as yielding a favourite food to the Elephant;[2] and the succulent 'Spekboom' *Portulacaria Afra*, or 'Tree Purslane,' is noticed by most travellers as yielding another.

That the African Elephant, such as we now see it, formerly extended to the South of Europe, has been put beyond question—1st, by the researches of Lartet upon remains found in the neighbourhood of Madrid;[3] 2nd, by the remains discovered by Baron Anca in the cave of San Teodoro in Sicily;[4] 3rd, by a molar from Grotta Santa, near Syracuse, described by the Canon Alessi,[5] and identified by myself; and lastly, by a molar exhumed by M. Charles Gaudin, in 1858, in a cave near Palermo. The last specimen has lately been transmitted to me for examination, and it proves that the African Elephant existed in that island as the cotemporary of the two extinct species of Hippopotamus of the Sicilian caves. The reputed cases of molars of the African Elephant, from the Valley of the Rhine, described by Goldfuss, I believe to be spurious fossils, after having submitted them to a careful examination.[6] Captain Spratt, R.N., the indefatigable explorer of the Hydrography and Geology of the Mediterranean, has, as already stated, lately discovered in Malta numerous remains of a surprisingly small fossil

[1] Cited in the 'Library of Entertaining Knowledge.' Menageries, vol. ii. p. 36.

[2] *Acacia Elephantina*, Burch. 'Travels in South Africa,' vol. i. p. 236. *Elephantorhiza Burchellii*, Benth.

[3] Comptes Rendus. 22 fév. 1858. Tom. xlvi.

[4] Bullet. Soc. Géol. de France. 2e Sér. t. xvii. p. 684. Pl. xi. figs. 5 & 6.

[5] Atti dell' Accad. di Scienz. Natur. tom. vii. p. 223.

[6] Nova Act. Acad. Natur. Curios., tom. x. Pl. xliv., and tom. xi. p. 2, Pl. lvii. fig. 1. A specimen of a reputed fossil molar, of *E. Africanus priscus*, in the Museum of Rudolstadt (Schwarzburg), direct testimony to the authenticity of which was borne by the finder when the case was investigated on the spot by Sir Charles Lyell, proved, on examination in London, to be of a recent African Elephant.

Elephant, of the sub-genus *Loxodon*, which I have named *E. Melitensis*.

Of the more ancient European fossil species, *E. antiquus* is that which most resembles the African Elephant in the mesial expansion of the discs of its worn molars. But the character is shown in a much less degree, and the great difference in the ridge-formula of the two species places them in two distinct sub-genera. *E. antiquus*, in the series, is intermediate between *E. Indicus* and *E. Africanus*, but more nearly allied to the former. The crowns of its molars indicate alimentary habits intermediate between those of the two living species.

(*c.*) *Food of the Mammoth.*—In order to estimate the force and value of the arguments which have been raised on this head, it is necessary to institute a rigorous comparison between the mechanical conditions of the molar-crowns of the Indian Elephant and of the fossil species.

The ridge-formula is the same in both, being for the four last teeth of the upper jaw 12 : 12, 16, 24. The number of ridges in the three first of these is very constant; the last, as already stated, is variable within certain limits, twenty-two being the most common number. Taking the penultimate, as in the case of the Indian Elephant, the worn surface of the crown would show sixty-four alternations of unequally hard materials.

Although agreeing in this essential respect, there are important differences in the mechanical disposition of the plates. In *E. primigenius* the molars are shorter for the number of their constituent ridges, and their crowns are also, both absolutely and relatively, broader than in the Indian species. The alternate successions of cement, enamel, and ivory, are therefore more attenuated and more condensed, and a larger number of them enter into the surface of that part of the tooth which is in wear. Lartet fixes the number of ridges that may be in active use at from twenty to twenty-three in a length of about 9½ inches (0·24 mèt.); while in the adult Indian Elephant the number of bands in the same length is usually about sixteen. But the great difference lies in the mechanical properties of the enamel-plates. Instead of being thick and robust, with close-set and regular undulations, or zig-zags, as in the Indian species, they are thin and parallel, the projecting edges running either straight across, or if there is a tendency to undulation, it is but slight, fine, and inconstant; occasionally, even, there is irregular angular expansion, or flexuosity in the edges of discs that are worn low down; but, as a general rule, the plates are straight and free from waviness. It is this cha-

racter which involves the greater width of the molar-crowns in the Mammoth; if the undulations of the Indian Elephant were unfolded, the crown-plates would in that species be as broad as in the fossil one. Another difference is, that these plates are higher in the Mammoth. In the Texan specimen of an upper molar, mentioned above (p. 229), they attain the enormous height of nearly eleven inches.

The triturating surface of the crown in the active molar presents another and very significant difference. Instead of the terraced inequalities, seen in the molars of *E. Columbi* and *E. Indicus*, as described above, the worn surface in the Mammoth is nearly flat; the enamel-edges rising but a very little above the ivory and cement. This is a constant character of Mammoth-molars of all ages and of all regions, whether from the pre-glacial 'Forest-bed' of the Norfolk coast, from the volcanic gravels around Rome, from the superficial gravels of England, from the frozen soil at the mouth of the Lena, from Eschscholtz Bay, from the swamps of the Ohio, or the prairie lands of Texas. In fact, the normal condition of the molar-crown of the Mammoth resembles that of the Indian Elephant, which has been fed in captivity, but without the distorted arrangement of the plates seen in the latter. This observation, so far as I am aware, has not been made before; and the fact will explain the reason why I have entered so much in detail into the cause of the unnatural condition in the captive Asiatic species.[1]

What, then, was the nature of the food of the Mammoth? In speculating on this question, we have for our guidance:—1st, the mechanical properties of the molar crowns as a disintegrating apparatus; 2nd, the analogy of the living species; 3rd, the climate and implied vegetation of the habitat of the extinct animal.

Regarded as an instrument for crunching and contusing the woody fibre and tough bark of trees, the crown of the molar in the Indian Elephant is manifestly much more powerful than that of the Mammoth. The elements which determine the ratio of force in the comparison are the

[1] The distorted condition of the molars of the subjugated existing species is occasionally, although very rarely, seen in the teeth of the Mammoth. A fine example is presented by a last true molar of the upper jaw, preserved in the Woodwardian Museum of Cambridge, in which the five last plates are contorted and crowded on one side. It might serve for the molar of a Mammoth which had been in bondage to man of the early 'Flint-knife' period. But a natural cause of this condition is intelligible, on the supposition that the molar which preceded it was not opposed by a corresponding tooth in the lower jaw; a deficiency which is known to occur, from disease or accident, both in living and extinct forms. [See *antea*, p. 169, and vol. i. p. 430.—Ed.]

strength, projection, and number of the enamel-edges, the ivory and cement being, in the mechanical aspect, but the setting in which the plates are fixed. In the molar of the Indian Elephant they are like the edges of thick plates of corrugated iron, having a considerable amount of relief; while in the Mammoth they are like the edges of thinner flat plates of the same metal, barely elevated above their level setting, but more numerous, in the same extent of grinding surface, in the ratio of 5 to 4. In the former, the tough and ligneous matters which it is known to select for its food tell upon the triturating elements, as might be predicated, in the ratio of their densities. The soft cement is worn lowest, the plate of ivory forms a depressed band, and the enamel-plates project over both—the wider intervals by which they are separated contributing to facilitate the mechanical result required in the case. In the Mammoth the plane of the setting remains flat, and the enamel-edges are but slightly in relief above it. The molar in the palate of a Mammoth from Eschscholtz Bay, in the Palæontological gallery of the British Museum, may be cited in illustration. If hard woody fibre entered more largely into the food of the fossil than it does into that of the existing species it is difficult to conceive why corresponding mechanical results should not have followed, in the greater proportional erosion of the cement.

It has been argued, and the reasoning has met with very general acceptance,[1] that 'if we find in an extinct Elephant the same peculiar principle of construction in the molar teeth' (*i.e.* as in the living forms), 'but with augmented complexity, arising from a greater number of triturating plates and a greater proportion of the dense enamel, the inference is plain that the ligneous fibre must have entered in a larger proportion into the food of such extinct species.'[2] But there are objections to the terms here used, as accurately expressive of the difference, which are opposed to the inference. It is true that there is a greater number of thinner enamel-plates, in the same extent of triturating surface, which thus becomes more *composite*; but it is not so that there is a greater proportion of dense enamel, nor that the crown is more *complex*. The greater thickness of the plates in the Indian species compensates for their more frequent repetition in the fossil form; while their strong undulation

[1] The deduction here referred to has been adopted by the distinguished authors of the 'Geology of Russia,' in their disquisition on the '*Habitation and Destruction of the Mammoths*,' with a very high estimate of its importance, as a result of palæontological research. *Op. cit.* vol. i. p. 497.

[2] Brit. Foss. Mamm., p. 268.

in the former necessarily renders the grinding surface much more complex than in the latter. Let any one look at the beautiful figure of the molar crown of the Indian Elephant in the 'British Fossil Mammalia,' cut 90, p. 233, and compare it with cut 92, p. 237, of the Mammoth; the contrasted differences are obvious at a glance. The latter is a mechanism for finer disintegration; but the former, from its conjoint properties of greater strength, complexity, and inequality of surface, is a more powerful apparatus for crushing and contusing hard ligneous fibre.

For these reasons I cannot assent to the soundness of the asserted physiological inference, that a coarser kind of vegetable food and a larger proportion of ligneous fibre must have entered into the subsistence of the Mammoth than enter into that of the living Asiatic species, or that there was any necessary relation between the peculiar structure of its teeth and the subarctic arboreous vegetation of Siberia, seeing that the same structure holds in the molars of the pre-glacial Mammoth of the Norfolk coast, and in that of Central Italy. Professor Owen has taunted the great observers who preceded him with having failed to follow up the inquiry regarding the Siberian Mammoth to its legitimate consequences:—

'It might have been expected that the physiological consequences deducible from the organization of the extinct species, which was thus, in so unusual a degree, brought to light' (*i.e.* the Adams-Mammoth), 'would have been at once pursued to their utmost legitimate boundary, in proof of the adaptation of the Mammoth to a Siberian climate; but save the remark, that the hairy covering of the Mammoth must have adapted it for a more temperate zone than that assigned to existing Elephants,[1] no further investigation of the relation of its organization to its habits, climate, and mode of life appear to have been instituted; they have, in some instances, indeed, been rather checked than promoted.'[2]

It is certainly unexpected to see it insinuated that it was left to Pictet to point out, in 1844, that the long hair of the extinct species appeared to fit it for sustaining a greater degree of cold than that which the Indian Elephant now bears. Nearly a century ago Pallas threw out the same conjecture regarding *Rhinoceros tichorhinus*, upon the hair with which it was covered; while Cuvier expressed his opinion on the subject with characteristic precision. After

[1] 'La longue toison dont cet animal était couvert semblerait même démontrer, qu'il était organisé pour supporter un degré de froid plus grand que celui qui convient à l'éléphant de l'Inde.' Pictet, Paléontologie, 8vo. tom. i. 1844, p. 75.

[2] British Fossil. Mamm., p. 267.

describing the nature of the hair of the Mammoth, he adds: 'Par conséquent, il n'est pas douteux que l'éléphant fossile, *tel qu'il se trouve en Sibérie,* avait une fourrure d'animal de pays froids.'[1] Again: 'Ainsi non seulement il n'y a rien d'impossible à ce qu'elle ait pu supporter un climat que feroit périr celle des Indes, il est même probable, qu'elle étoit constituée de manière à preférer les climats froids.'[2] Here it will be observed that Cuvier, with philosophic caution, limits his argument to the extinct animal, such as it occurs in Siberia, believing, as he did, that the species had also existed in more temperate regions. But we now know that the Mammoth roamed over Europe before the Glacial period. Take the cases where its remains have been found in the 'Forest-bed' of the Norfolk coast and in the volcanic gravels around Rome. In the former, the vegetation, arboreous and herbaceous, according to the determinations of Heer, closely resembled that of the existing period, and the pre-glacial Mammoth subsisted upon it, in association with *Elephas antiquus, Hippopotamus major,* and *Rhinoceros Etruscus.* The Valley of the Tiber, between the Seven Hills, was formerly a great lake,[3] more than 130 feet above the present level of the river, receiving the volcanic ashes and other *ejecta* of the surrounding active craters, and forming enormous beds of travertine and gravels, in which remains of the true Mammoth occur associated with *Elephas antiquus, Rhinoceros leptorhinus* (*megarhinus,* Christol), and a species of extinct *Hippopotamus.* No one, at the present day, will be hardy enough to maintain that the Flora of Central Italy was at that time identical with, or as limited in the number of Arctic species as that of Siberia, where the wool-clad variety of the north lived and pastured; for we have distinct proof that the glacial refrigeration, which characterized the Alpine valleys and plains of Europe north of the Alps, was greatly modified in intensity on the southern side of the chain. The enormous glacier of the Valley of the Adige, after emerging from the 'Lago di Garda,' melted away, leaving on the margin of the Valley of the Po a vast mass of moraine. On the southern side of the Apennines, glacial phenomena have nowhere as yet been traced down upon the plains on their flanks. Yet the Mammoth existed in Central Italy, either before that period of refrigeration began, or when its effects told, but inconsiderably, in that southern latitude. It would therefore be as legitimate to detect a special relation between the composite structure of the teeth, and the vegetation upon which they were exercised, in the Mammoth of the South of

[1] *Oss. Foss.* 4to Edit. tom. I p 196.

[2] *Idem.* p. 200

[3] Hoffmann, Edinb. New Philos. Journ. 1829, vol. viii. pp. 85 and 96.

Europe, as in the asserted case of the Mammoth of Northern Asia.

Again, let us take the case of the Mammoth of Texas, and of the other Southern States, bordering the Gulf of Mexico. It will hardly be asserted, at the present day, that the same arboreous vegetation extended from the upper parts of the valleys of the Obi and Irtish across northern Asia, and from Behring's Straits across the surface of North America to the warm latitude of the Gulf of Mexico. Granted that the refrigeration of the Glacial period extended so far south, it must have been greatly modified in intensity by the southern latitude, as it was in the south of Europe; and that modification was incompatible with a tree vegetation restricted to pines, birches, poplars, willows, and junipers. We further know, that when the Mammoth pastured along the margins of the great swamps of Ohio and Kentucky, the vegetation then was nearly identical with what it is now, being very different from that of Siberia.

An inconsistency of the advocates of the doctrine here combated is worthy of notice. While so strongly insisting on the special relation between the teeth of the Mammoth and the leafless tree vegetation on which he fed during winter, it was asserted that the variety of molar on which *E. meridionalis* is founded occurs not only in England but in Siberia, and as far north as Eschscholtz Bay.[1] It is well known that the teeth of the latter species possess characters which are very different from those of the former; having thick enamel-plates, which are few in number and wide apart. The special adaptation, between the teeth and food, which held in the one was therefore absent in the other, although, under the view here referred to, they were both said to be found in the same Arctic localities, where they must both have subsisted on the same impoverished Flora.

The state of our exact knowledge, at the present time, regarding the duration, geographical range, climate, habits, and food of the Mammoth, appears to be thus. The species existed before the Glacial period in Europe, and survived long after it in Europe or America. The constitutional flexibility, which is implied by its 'dicyclotherian' term in time, is equally evinced in its vast geographical range of habitat; extending from the valley of the Tiber to the Lena, and from Eschscholtz Bay to the shores of the Gulf of Mexico. Making due allowance for the interference of the glacial phenomena, the extremes of north and south latitude, in which undoubted remains of this ancient Elephant have been found, necessarily imply that his constitutional flexi-

[1] Brit. Foss. Mamm., p. 238.

bility was, like that of man, capable of adaptation to very great differences of climate. In Siberia, he was 'enveloped in a shaggy thick covering of fur, like the Musk Ox, impenetrable to rain or cold.'[1] But we are not obliged to suppose that in his southern habit he was thus clad. The dermal appendages are very variable and adaptive, according to climate. The fine silky fleece, from which the Cashmeer shawls are wove, is abundantly developed at the roots of the long hairs of the domestic goat in the plains of Tibet, at, and upwards of, 16,000 feet above the level of the sea, where a highly rarified atmosphere is combined with severe winter cold. It grows also, on the Kiang, the Yak, *Cervus Wallichii*, the Brown Bear of high elevations in the Himalayah, and on the Mastiff Dog of Tibet. But it disappears entirely from the same Goat, and from the Dog, in the valley of Cashmeer. The short crisp wool of the Siberian Mammoth, which seems to have been the most protective portion of his fur, may, in like manner, have disappeared from the variety that lived in the valley of the Tiber, while the bristles and long coarse hair were more or less retained; and it is in the highest degree probable that the species presented varieties of external form, dependant on the nature of the dermal clothing, far exceeding those which are seen in existing Elephants. That the Siberian Mammoth migrated periodically, from the more southern forests, towards the Polar Sea, during summer, as his surviving cotemporaries the Musk Ox and Reindeer now do, is also highly probable;[2] but we have no grounds to believe that the Mammoth of Southern Europe ever made migrations to the north of the Alps.

The same constitutional elasticity which enabled the Mammoth to endure such a variety of climates, and to spread over such a vast geographical area, necessarily extended to his alimentary habits. I have already called attention to the remarkable constancy in the specific characters of the molar teeth, alike in the pre-glacial and post-glacial, in the extreme northern and the extreme southern forms. Their adaptation was not special to the vegetation merely of Siberia, but general to that of every region over which the species spread; and up to the present time not a plausible conjecture even has been offered as to the class of vegetable matters which they most affected. The question of the food of the species has not been, in the least, advanced since the discovery by Adams of the ice-preserved carcass on the banks of the Lena in 1803, or since the philosophic doubts were expressed by Fleming on the subject in 1829.[3] Wher-

[1] Fleming Edinb. New Phil. Journ. 1828, vol. vi. p. 285.
[2] Richardson. Polar Regions, 1861, pp. 275 and 296.
[3] Edinb. New Phil. Journ. 1829, vol. vi. p. 285.

ever a certain result has been arrived at regarding the alimentary habits of the extinct Mammalia of the Glacial period, it has only been by discovering the remains of the food itself in some of the organs of digestion. We have the authority of Brandt for the fact, that he extracted from the pits of the molar teeth of the *Rhinoceros tichorhinus*, of which the carcass was obtained by Pallas from the banks of the Wiljui, part of the albuminous seed of a Polygoneous plant, portions of Pine leaves, and minute fragments of coniferous wood, characterized by the distinctive porous cells.[1] In like manner, four cases have been described in North America, where the contents of the stomach and intestines of *Mastodon Ohioticus* appear to have been preserved along with the skeletons; and the facts recorded by different observers are so much in accordance as to leave little room for doubt on the subject.[2] Broken pieces of branches, varying from slender twigs to boughs half an inch in diameter and about two inches long, were found mixed up with more finely divided vegetable matter, like comminuted leaves, in one case to the amount of from four to six bushels. We have the authority of Gœppert for the fact, that twigs of the existing coniferous *Thuia occidentalis* were identified in the stomach of the New Jersey Mastodon; and of Professor Asa Gray and Dr. Carpenter, both eminent microscopical observers, that the stomach of the Newburgh Mastodon contained fragments of the boughs of 'some coniferous tree or shrub, and probably some kind of spruce or fir (Gray); and also fragments of a quite different kind of wood (not coniferous), which from its decomposed and carbonaceous state was not determinable (Carpenter).' But these observations do not, in the slightest degree, advance our knowledge as to the probable food of the Mammoth; residuary bits of stick, half an inch in diameter, are reconcilable with the masticatory operation of the rude open valleys and *Trilophodont* ridges of the molars of the American Mastodon; but in the highest degree improbable as a result of the multiplex divisions of the flat molar crown of the Mammoth. We must be content to remain in the dark on this question, until the same kind of observation is applied to the contents of the stomach of the latter in Siberia,[3] as has been so successfully effected with the allied genus in North America.

[1] Leonhard and Bronn's 'Jahrbuch,' 1846, p. 378; and Bronn's Lethæa Geognost., band. iii. p. 855.

[2] Warren. 'Mastodon Giganteus,' p. 166.

[3] In the researches upon the latest discovered Mammoths in Siberia, of which the details have been published, the remains of the brain, muscles, tendons, and periosteum have been microscopically examined, but not the contents of the stomach. (*Vide* Gleboff, Bullet. Soc'ét. Impér. de Moscou, 1846, xix. 2, p. 108, *et seq.*)

IV. ON THE FOSSIL REMAINS OF ELEPHAS MELITENSIS, AN EXTINCT PIGMY SPECIES OF ELEPHANT; AND OF OTHER MAMMALIA, &c. FROM THE OSSIFEROUS CAVES OF MALTA.[1]

AMONG the most interesting of the fossils from the Zebbug Cave is a series of molar teeth and fragments of tusks, referred to in Captain Spratt's papers as belonging to a fossil Elephant. The molars comprise specimens ranging from the first milk molar of very young animals up to what appear to be adult teeth, and they are at once characterized, besides other differential marks, by the singularly small size of the species which yielded them. Warned by the great blunders committed by Nesti, Fischer de Waldheim, and other palæontologists, in having been misled by the characters of milk teeth, to identify them as the remains of pigmy species of Elephant, I have been chary in admitting the convictions, which the specimens forwarded by Captain Spratt forced upon me when I first examined them. One of the most characteristic of these is an upper molar of the left side, bearing the following label. 'Dente che si conserva nella Púbblica Bibliotéca di Malta, e trovato in Novembre 1859 in Malta.' As this specimen is about to be returned to Malta, at Captain Spratt's request, it is necessary to make an accurate description of it, to accompany the figures drawn by Mr. Dinkel. (Pl. XI. figs. 1 and 1 *a*.)

The tooth is a well-worn upper molar of the left side, perfect so far as the crown goes, with the exception of the

[1] This description of the teeth of *Elephas Melitensis* formed the substance of a communication by Dr. Falconer to the meeting of the British Association at Cambridge, on October 6, 1862. From the appended letters and notes, however, it will be seen that this as well as other fossil remains, found by Capt. Spratt in the caves of Malta, were identified by Dr. Falconer as early as July 1860. Dr. Falconer had drawings taken from the original specimens by Mr. Dinkel, some of which are here reproduced. They included illustrations of the vertebræ, pelvis, scapula, humerus, femur, &c. These bones were subdivided by Dr. Falconer into three classes, viz.: old, young, and fœtal, but the only description of them left by him is contained in the appended extracts from his note-books. This defect, however, will, I believe, be amply remedied by Mr. Busk, in a memoir which will shortly be published in the 'Zoological Transactions,' and which contains the account of a second species of Elephant, discovered by him among the fossil remains from Malta, and designated by him [illegible] *Falconeri*. Capt. Spratt's account of the caves whence the fossils were derived will appear in an early number of the 'Quarterly Journal of the Geological Society.'—[ED.]

front portion supported upon the large anterior fang, which had been worn away by continued grinding action. This is distinctly proved by the circumstance that the grinding plane of the crown intersects the most anterior of the extant fangs. The rest of the fangs from this point backwards to the posterior talon are all present, but more or less fractured or abraded. The molar is vertically fractured across through the middle, involving the loss of the greater part of one colline, but as the fragments fit at the base this circumstance does not interfere with the precise appreciation of the crown characters. What remains of the crown is composed of ten ridges, of which nine are more or less worn, the rest being intact. The posterior talon consists of a single flattened gibbous digitation appended to the last ridge, which is composed of three or four digitations. The most anterior disc of wear is vertically divided through the middle, so that the posterior half of it only is present. The seven anterior discs form oblong transverse depressions, bounded by *parallel* bands of enamel; there not being the slightest tendency in any of them either to crimping or to digital subdivisions forming secondary undulations. These discs are nearly of uniform width across, parallel, and without any indication of the retroflected cornua at the sides, such as are commonly seen in *Elephas antiquus*. The most striking character about these discs is the nearly entire absence of anything approaching crimping (or primary undulations) upon the edges of the enamel-plates, as they are shown in relief upon the surface of the crown. There is a slight appearance of vertical grooving upon the cement aspect of these enamel-plates, but considerably less than is exhibited by the molars of any species of Elephant, fossil or recent, with which I am acquainted. The enamel of the plates is rather thick, quite as thick in proportion as in the existing Indian Elephant or *Elephas antiquus*. There is the slightest possible tendency to mesial angular expansion in some of the anterior discs, but it is barely appreciable, while in some others of the specimens this character is somewhat more pronounced. The talon consists of but a single flattened digitation, and there is this remarkable circumstance about it, that it does not anywhere bear the slightest indication of any disc of pressure upon it, arising from the protrusion of another molar advancing from behind. The last or tenth ridge of the specimen I have reckoned as such, and not as a talon appendage, from the fact that it is continued vertically down into the large posterior fang, and distinctly within its bearing. The crown, in proportion to the height of the plates, is narrow. The discs of wear are much abraded

in front and are in close contact, the enamel-plates nearly touching each other, but they are well separated backwards, and the whole of the crown is enveloped by a coat of cement, which at the sides is seen to be of considerable thickness.

I have reckoned that what remains of the crown is composed of ten ridges, and taking into account that the most anterior portion, supported upon the large front fang, had disappeared by age, and that it probably was composed of at least two ridges, this would yield for the ridge-formula of the molar a total of twelve collines, exclusive of talons.

What was the age of this molar in the dental series of the animal? At the first glance it might be supposed from its size to be a third or last milk molar, but this inference is at once negatived by the fact already remarked on, that the posterior talon bears nowhere upon it, or upon the end of the tooth, the slightest indication of a depression arising from the pressure of a tooth advancing behind it. As the same result is yielded in a still more decided fashion by the inferior molars, to be noticed in the sequel, I see no alternative to the inference that it was an adult tooth of a dwarf species of Elephant. The following are the dimensions :—

Extreme length of crown measured from back talon to anterior edge, exactly 4· in. Width of ditto at 2nd ridge, 1·4 in. Ditto at 3rd ridge, 1·5 in. Ditto at 6th ridge, 1·4 in. Greatest width of crown, 1·55 in. Width at 10th ridge (greatest), 1·2 in. Ditto at last ridge, 1· in. Greatest height of crown taken at reflection of 10th ridge, 2·95 in. Length occupied by the five discs from 2nd to 6th inclusive, 1·8 in. Width at middle of 3rd disc taken between the enamel-edges, 0·23 in.

With reference to the alimentary characters, the discs of ivory and the cement hollows between the enamel-ridges are but slightly excavated; in fact, the most anterior portion of the crown exhibits the flat and nearly uniformly smooth surface which is commonly presented by Elephants reared in the domestic state and fed upon potatoes or other soft food. The inference drawn from this is, that the food of the Malta species was more herbaceous than woody. Mr. Dinkel's figure of the crown-surface of this tooth is not quite satisfactory in the details of the enamel-edges, but on the whole is a good representation of the tooth.

Upper True Molars.—The specimen next to be noticed (Plate XI. figs. 2 and 2 *a*) is a very beautiful and finely-preserved molar of the upper jaw, right side, complete in every respect, with the exception of the ends of the fangs, which are more or less broken off. The crown is composed of nine principal ridges, together with a front and a back talon. The front fang is distinctly present, and is seen to support the two front ridges and talon. Of these, the eight anterior ridges are more or less affected by wear, the rest being intact.

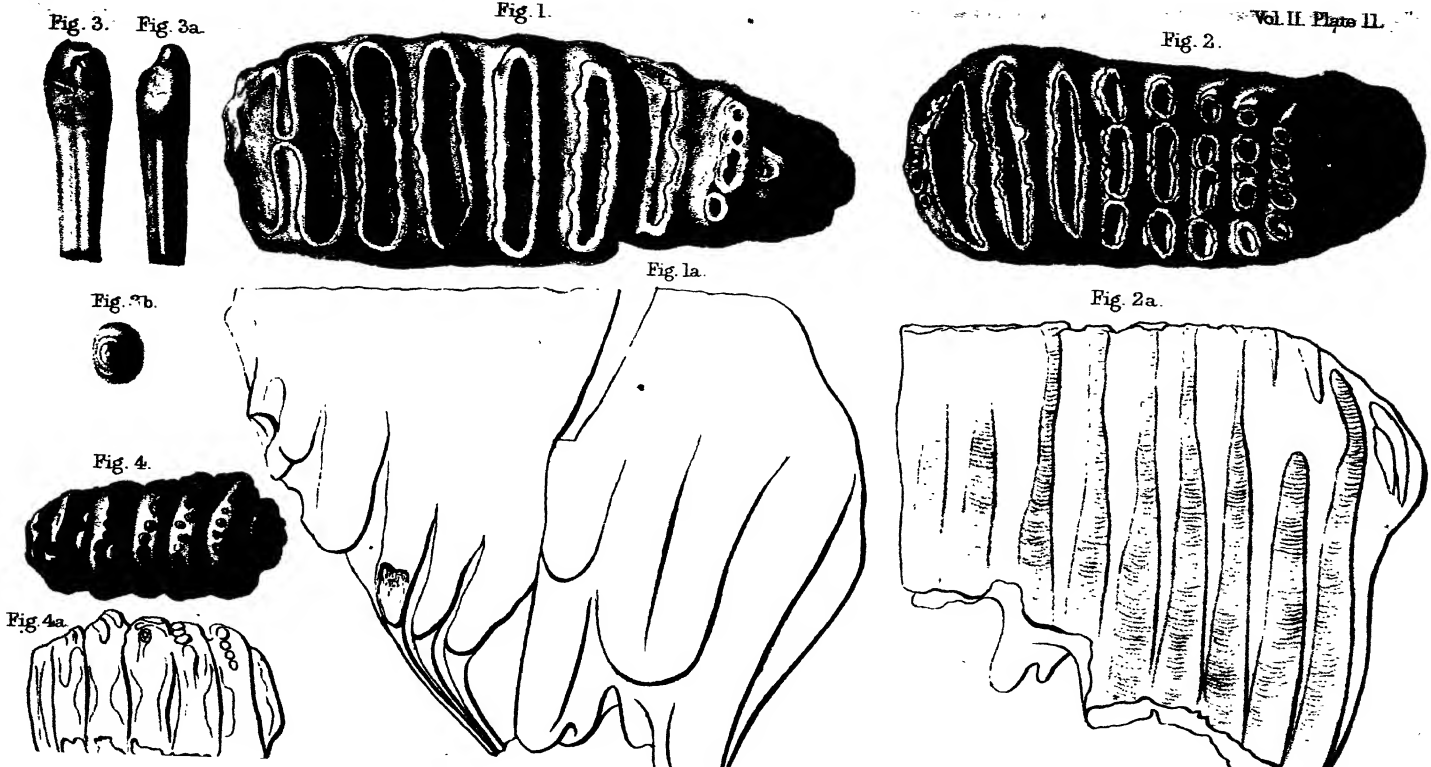


Fig. 1.
Fig. 1a.
Fig. 2.
Fig. 2a.
Fig. 3.
Fig. 3a.
Fig. 3b.
Fig. 4.
Fig. 4a.

The front talon appears to be composed (what remains of it) of a couple of digitations, the greater part of it having already been ground away, or become confluent with the front ridge. The three anterior discs are transverse, the next five are only slightly affected by wear, showing the tips of the digitations abraded into annular detached discs, or in three divisions. The anterior disc is expanded in the middle, and narrows at either side, and presents only two or three flexures in the enamel-plate, without crimping. The second and third are nearly of a similar form, with uncrimped enamel, and narrowing at the sides. The fourth, fifth, and sixth are each in three divisions, and the seventh and eighth only show the tips worn across. The enamel-plates are decidedly thick for the size of the tooth, and the ridges are very high relatively to the length. The layer of cement at the anterior end has been removed, and with it all appearance of a disc of pressure. The hind talon forms a gibbous projection beyond the vertical plane of the posterior fang. There is no distinct disc of pressure upon the crown portion of the talon, but there is an obscure depression at the basal part near the fang, which may be of this nature. The following are the dimensions :—

Extreme length of crown, 2·9 in. Width in front, 1·35 in. Ditto in the middle, 1·3 in. Ditto behind, 1·1 in. Length of surface occupied by the eight anterior discs of wear, 2·2 in. Extreme height of crown at unworn portion, 9th ridge, 2·8 in.

From the above dimensions, the contraction of the crown backwards and the considerable height of the ridges relatively to the length of the crown are well shown.

Had this specimen been discovered isolated, little or no hesitation would have been entertained by the Palæontologist in referring it to the age of a milk molar of some species of Elephant. But when regarded as part of a series in connection with the undoubted milk molars (fig. 4 of Plate XI., and figs. 1, 2, and 3 of Plate XII.), the whole of which are of such unusually small proportions; and when further compared with the adult molars of the lower jaw, of which one is figured in Plate XII. figs. 4 and 4 *a*, and the upper molar (figs. 1 and 1 *a* of Plate XI.), it is manifest that it maintains its place consistently as a true molar of the same series. I am at present unable to decide with confidence whether it had best be regarded as a penultimate.[1]

Of the antepenultimate upper true molar (m. 1) no perfect specimen is to be found in the collection. One fragment, inferred to be a part of this tooth from its size, form, and proportions, comprises the two anterior ridges, together

[1] At page 298 it is spoken of as the penultimate.—[Ed.]

with the large fang that supports them. The corresponding molar of the lower jaw is equally wanting as an entire specimen; but there are fragments referable to it also.

Milk-Tusks.—The Zebbug series fortunately includes a very perfect milk-incisor, which confirms the line of specific affinities indicated by the molars. The specimen is represented of the natural size by Plate XI. figs. 3, 3 *a*, and 3 *b*. It differs from the permanent tusk in having the crown and fang portions distinctly defined. The crown forms an obtuse, flattened, rounded, and irregularly indented body, invested with a thick shell of enamel, and supported on a long cylindro-conical fang, part of which is broken off, near the end. From the diameter of the broken end and of the central canal, it is manifest that at least a third of the entire length of the fang is wanting. The specimen was compared with the corresponding tooth of a fœtal African Elephant belonging to a skull transmitted to the British Museum by Dr. Livingstone, in which the milk molars are quite unworn. The two agree very closely in the dilated blunt form of the crown, the investing shell of enamel and the defined fang. The chief difference detected between them was in the form of the fang, which in the young African Elephant forms a rather short compressed cone, terminating in a sharp slender point; while in the Zebbug fossil the fang is stouter, more cylindrical, and much more elongated.

The dimensions of the fragment are:—

Joint length of crown and fang, 1·4 in. Length of crown, 0·6 in. Width of ditto, 0·4 in. Thickness of ditto, 0·3 in. Length of fang portion (imperfect), 0·9 in. Diameter at the collar, 0·3 in. Ditto at broken extremity, 0·25 in.

These minutiæ are given in so much detail, in order to mark the affinity which the Malta fossil bears throughout its dentition to the African Elephant. A shell of enamel has not yet, so far as I am aware, been detected in the milk incisors of any species of the subgenus *Euelephas*. It occurs in those of the African species, and I have detected it, forming a sheath upon the points of the young permanent tusks of *E. insignis*, belonging to the group *Stegodon*.

Permanent Incisors.—The collection contains numerous fragments of Elephant tusks, for the most part amorphous pieces or splinters of the outer layers, many of them bearing distinct marks of having been gnawed, but indicating tusks of very considerable diameter, and out of all proportion to the small Zebbug molars. These fragments, which appear to indicate another and larger species of fossil Elephant, will be noticed in the sequel. There is only one determinable specimen which will admit of being referred to the smaller

form, and that only conjecturally. It consists of a portion of the dental end of a slightly curved tusk, about five inches in length. The greater part of the outer layer, which is weathered, of a greyish tint, has disappeared by dislamination. The butt end yields a round section, slightly compressed at the sides. The outer layer is smooth, and throughout a line of thickness shows no appearance of engine-turning. Beneath it the ivory-surface is very distinctly channelled longitudinally and regularly, and the section inwards to the core exhibits very distinct engine-turning, more pronounced even than is commonly seen in Proboscidean tusks, the inequalities being nearly as marked as upon a sailor's thimble. The specimen tapers to a conical point.

The dimensions are:—

Length of fragment, 5·0 in. Vertical diameter at butt end, 1·15 in. Transverse ditto, 1·0 in.

The tusk here described would correspond in size with the true molar of the Malta form.

Ridge-formula.—It now remains to consider how the data furnished above by the molars bear upon the determination of the ridge-formula, which of all the characters is the most significant in pointing out the affinities of the species.

Milk Molars.—The antepenultimate milk molar (m.m. 2) is seen by Pl. XII. figs. 1 and 1 *a*, to have been composed of three collines, like the corresponding tooth of the African Elephant; while in *E. primigenius*, *E. Indicus*, and other species of the sub-genus *Euelephas*, it presents four collines.

The penultimate (m.m. 3) is clearly proved by the upper germ specimen (Pl. XI. figs. 4 and 4 *a*), and by the lower (Pl. XII. figs. 2 and 2 *a*), to have had five collines, besides front and back talons. In the African Elephant it is composed commonly of five ridges in the upper jaw, and six in the lower; while in the species of Euelephas it ranges from seven to eight; seven being the complement of *E. antiquus*, and eight that of the Indian Elephant and Mammoth.

Of the last milk molar (m.m. 4) the specimen represented in Pl. XII. figs. 3 and 3 *a*, fortunately presents the crown of an inferior tooth, in perfect integrity, composed of eight ridges in addition to a front and hind talon. The African Elephant commonly yields the same number; while in *E. antiquus* the number is ten, and in *E. primigenius* and *E. Indicus* it amounts to twelve.[1]

[1] *Extract from Dr. Falconer's Note-book.*—'British Museum, July 26, 1860. Compared the perfect specimen of last milk molar of lower jaw of Elephant from Zebbug with two specimens (Nos. 18,810 and 21,655) of the last milk molar of *Elephas antiquus* from Grays, in Essex. In No. 18,810, the crown is more worn than in the Zebbug tooth, and there is a very large disc of pressure

True Molars.—Of the antepenultimate true molar (m. 1), there is no perfect specimen in the collection. But as in all the species of Elephant and Mastodon this tooth invariably repeats the composition of the last milk molar, we have no difficulty in fixing the normal number of its ridges to have been eight, besides talons. In *E. antiquus* the number is ten, and in the Mammoth and Indian Elephant twelve.

Of the penultimate true molar there is no entire specimen of a lower tooth; but we have the upper beautifully preserved in Pl. XI. figs. 2 and 2 *a*, and exhibiting a crown distinctly composed of nine ridges besides a front and a hind talon. In the African Elephant the same tooth is commonly made up of nine ridges. In *E. antiquus* the normal number is twelve, while in *E. primigenius* and *E. Indicus* it amounts to sixteen.

Of the last true molar (m. 3) there are fortunately specimens both of the upper (Pl. XI. figs. 1 and 1 *a*) and lower (Pl. XII. figs. 4 and 4 *a*) jaws; and although the portion supported on the anterior fang is wanting in both, as that constantly corresponds in all the species of Elephant with what is borne upon the same fang of the penultimate, we have little difficulty in restoring the missing part of the teeth. The upper molar (Pl. XI. figs. 1 and 1 *a*) exhibits the remains of ten ridges, and adding two for the part corresponding with the anterior fang we get a complement of twelve ridges for the crown of the last molar. In the African Elephant the same tooth in the upper jaw ranges about ten ridges, and in the lower from ten to twelve. In *E. antiquus* the number is sixteen, and in *E. primigenius* and *E. Indicus* they reach twenty-four.

From the above data the ridge-formula of the molar-series is deduced to have been thus:

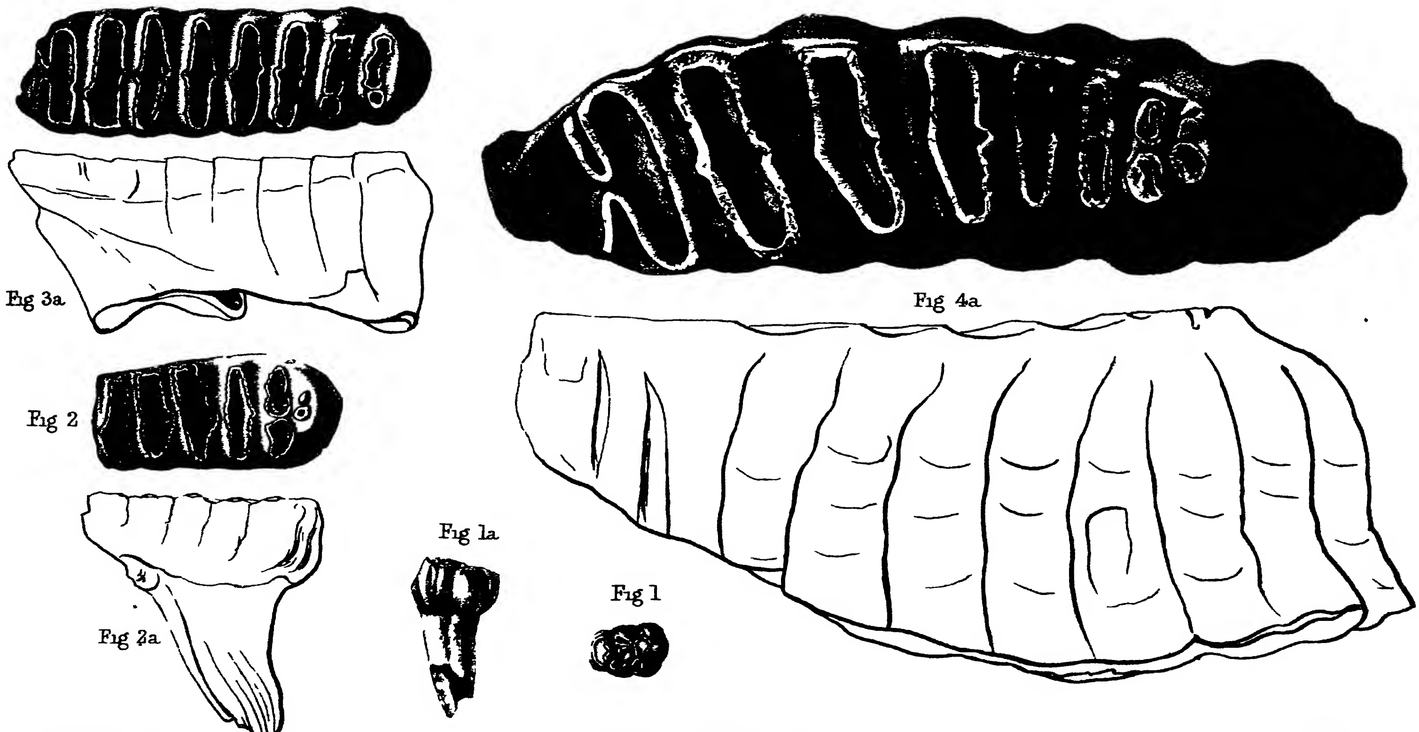
$$\overbrace{\frac{3+5+8}{3+5+8}}^{\text{Milk molars.}}\quad\overbrace{\frac{8+9+12.}{8+9+12.}}^{\text{True molars.}}$$

This formula at once brings the small Zebbug species within the subgeneric group of the Elephants, which I have called *Loxodon*, along with *E. Africanus*; the affinity of the fossil to the existing species is further clearly indicated by

behind; the enamel also is much more plaited and the crown much broader; it has seven ridges and talons, the anterior talon being worn low, and the bounding shell of enamel not quite complete in front. No. 21,655 has also seven ridges and talons, all of which are more or less worn; it is covered with an enormous mass of cement.

	Zebbug. m.m. 3.	E. antiquus. m.m. 3. 18,810.	21,655.
Length of crown . .	2·2	2·55	2·9
Width at second disc	·7	·85	·9
Greatest width behind	·7	1·4	1·3
Height of crown at seventh ridge . .	·7	1·4	—'

[Ed.]



J.Dinkel del. et lith.

Elephas Melitensis

W West imp

the narrow crown and by the tendency to mesial expansion of the discs of wear, together with the point already alluded to of the milk-incisors being invested with a layer of enamel. But although allied, the two forms are specifically very distinct. Besides the signal difference of size, the form of the discs of wear, although belonging to the common pattern, presents broad marks of distinction. In the African species the discs are angularly dilated into rhombs in the middle, and the angles terminate in a round loop, caused by a single outlying digital element, which in the progress of abrasion becomes confluent with the disc of the ridge to which it is appended. In the Zebbug form there is never a trace of this outlying loop, and the discs, although open, exhibit only but a very slight tendency to angular expansion. The character is most pronounced in the two milk-teeth (Pl. XII. figs. 2 and 3), while it is entirely wanting in the penultimate upper molar (Pl. XI. fig. 2). In fact, this tooth differs more from the ordinary type of the African species than does the corresponding molar of *E. antiquus*. The amount of agreement and of difference in the molars of the two species is best appreciated by comparing the last lower molar (Pl. XII. fig. 4) of the Zebbug form, with the corresponding molar of the African species.[1]

Elephas Melitensis is the name which I have applied to the new species. It was the pigmy form of the order. In size, it stood between a large Tapir and the small unicorned Rhinoceros of Java.

APPENDIX.

CONSISTING OF MEMORANDA, ETC., BY DR. FALCONER, ON FOSSILS FROM THE CAVES OF MALTA.

I.—Extracts of Letters from Dr. Falconer to Capt. Spratt, C.B.[2]

July 21, 1860.

'Your last researches in the Zebbug Cave are to me of very great interest. I am now occupied with them. The Elephant remains are of

[1] See Plate vi. fig. 1.—[Ed.]

[2] In May, 1860, Capt. Spratt despatched from Malta to the Geological Society of London the fossils which he had discovered in the caves of Zebbug, &c., and their examination was undertaken by Dr. Falconer at the beginning of July 1860. The collection included the tooth of *Elephas Melitensis*, already described as belonging to the public library of Malta, which Dr. Falconer returned to Malta in May 1862. Since Dr. Falconer's death a statement has been published in a Malta paper to the

the highest importance. They belong, not to the Mammoth, but to quite a distinct species.'

August 2, 1860.

'The cave fossils (from Malta) are turning out to be of great interest.

'From Krendi, the larger teeth-specimens are almost entirely of *Hippopotamus Pentlandi*, the Sicilian species. The teeth and small bones in the breccia are almost entirely of a new species of *Myoxus* or Dormouse, *Myoxus Melitensis*, of very large size, as big in comparison to the living Dormouse as the Bandicoot Rat to the Mouse.[1]

'From Zebbug there is a small species of Proboscidean, I believe quite new and allied to the Elephant, but not much bigger than a large Tapir. There are two fossil birds among the Zebbug bones. The best marked is an extinct species of Swan, which I propose calling *Cygnus Melitensis*. It was very much larger than any of the known existing species.[2] There are also some Reptilia not yet made out. But strange to say I have as yet detected no big Carnivora, although from the contracted tunnel form of the cave it is clear that the bones must have been dragged in by large Carnivora.'

effect that he was not the first to identify the *Elephas Melitensis*, and to place it in the subgenus *Loxodon*, on the ground that in a memoir communicated to the Royal Dublin Society in November 1861, but not published till 1863, an opinion had been incidentally expressed that a tooth in the Museum of the Maltese University presented markings on the crown differing from those of the Mammoth, but approaching those of the African Elephant. It may be well, therefore, to state that careful tracings of this tooth in the University Museum of Malta were transmitted by Capt. Spratt to Dr. Falconer, who pronounced it as entirely different from those of the pigmy Elephant, but 'allied to, if not identical with, the African Elephant.'—[Ed.]

Figures of the '*Myoxus Miletensis* (Nobis),' *sic*, accompanied a paper, entitled, 'Observations on the Fossiliferous Caves of Malta.' By Andrew Leith Adams, M.B., which was communicated to the Royal Dublin Society on November 18, 1861, and published in the Journal of the Society for 1863.—[Ed.]

[2] The fossil remains of this species of *Cygnus* were transferred by Dr. Falconer to Mr. W. K. Parker, F.R.S., who communicated an account of them to the Zoological Society on Dec. 12, 1865, from which the following passage is extracted:—

'The first species was a gigantic Swan, nearly one-third larger than average individuals of the Mute Swan (*Cygnus olor*). The head and more than half of the long bones belong to this kind. Its wings appear to have had the same relative length as those of the tame Swan; but the thigh-bone was relatively shorter, the tarso-metatarso (shank) was considerably longer in proportion. The most remarkable difference, however, between this extinct species (which I propose to call *C. Falconeri*) is to be found in the comparative length of the phalanges; for whilst the proximal joint of the middle toe is one-fourth thicker than that of the Mute Swan, it is only three-fourths the length; so that whilst *C. Falconeri* was between one-third and one-fourth larger than the common kind, it stood on longer legs, and had the comparatively short toes of a goose.

'The next species, that to which the important sternal fragment belonged, showing it to be a species of Hooper, I have doubtfully named *C. musicus* (?). Having recently examined the osteological specimens in the Museum of the College of Surgeons, which are attributed to *C. ferus* (see Cat. Mus. Coll. Surg. vol. i. p. 233, Nos. 1241-1248), I am strongly inclined to think, from the extreme difference of size, that some of the smaller ones belong to *C. Bewickii*. The smaller bones from Malta may either belong to small individuals (perhaps females) of *C. musicus*, or perhaps to the smaller *C. Bewickii*.'—[Ed.]

September 19, 1860.

'The Hippopotamus of Krendi is the same as the Hippopotamus of Sicily, viz. *Hippopotamus Pentlandi*, a species a little smaller than the living African form. The age of the animal in Sicily is certainly newer than the older Pliocene, because it overlies the Pliocene conglomerates. The Sicilian fossil Hippopotamus was not, at least on the northern side of Sicily, in connection with a great freshwater lake. It occurs mixed up with marine Bryozoa; and upwards of two hundred fossil Pliocene shells, all marine, occur in the deposit beneath it. Graves got the same Hippopotamus from the Tertiaries of Candia. I have examined the teeth in the College of Surgeons. Professor E. Raulin of Bordeaux also met with them in Crete, in a "yellow sandy loam of the Pliocene or newer Pliocene period, in the plain of Katharo, at an elevation of 1,150 mètres above the sea (say 3,750 feet). Katharo is to the east of the large plain of Passith, and east of the tow of Kritsa, on the eastern side of the Gulf of Mirabello." Raulin c -siders "that the plain of Katharo was formerly an intra-montane lak Lord Ducie, however, got a tusk of a *Hip. Pentlandi* which he co sidered to be from a deposit of a Miocene age. The swimming hypo thesis for the Hyæna will not do. Elephants will not swim across dee sea channels, nor Hyænas either. The case is clear—that there mus have been continuity of land between Sicily and Malta, and Sicily a Cape Bono, by Adventure Bank and the Skerki shoal.'

April 11, 1862.

'Although the Krendi Mammalia (the Hippopotamus) are the same species as those of Sicily and Crete, and of a newer Pliocene age, I cannot reconcile the Zebbug fossils as being of the same age, and I have a suspicion that they may be upper Miocene. The fossil Elephant of Zebbug is an undescribed species of prodigious interest, from its small size, &c. But there are no bones as yet of the skeleton, only the teeth, *and there are indications of another larger species*. It is of great importance that we should get a sight of all the materials that are available. There are numerous bones in your Zebbug Cave collection that are *fiercely* gnawed, and evidently by a large predaceous carnivore. But with the exception of a single tooth, of which the crown is completely hammered and denuded of enamel, and therefore indeterminable, there is not a single remain indicative of what this predaceous form was, whether Hyæna or something else; and until this point is cleared up, the history of the Malta caves will be incomplete.'

II.—Extracts from Dr. Falconer's Note-Books.

1. *List of fossil Elephant's Teeth, from Zebbug, in Captain Spratt's Collection.*

'No. 1 *a*. Milk tusk, with an enamel-shell. 1. Antepenultimate milk molar, probably upper, with a disc of pressure. 2. Germ of penultimate milk molar; has three plates unworn; probably of lower; no disc of pressure. 3. Penultimate lower, well worn, three discs and fang; also front disc of pressure. 4. Penultimate lower (right?) with disc of pressure. 5. Penultimate upper left milk molar in germ; no disc of pressure. 6. Last milk molar, lower; very fine, entire. 7.

Last milk molar, upper fragment, showing four ridges. 8. Last milk molar, lower? with section of three plates, fine. 9. Third milk (last) molar, upper; six ridges in fragments. 9 *a*. Much worn fragment of milk molar, three plates remaining. 9 *b*. Fragment of one semi-plate of ditto. 10. Symphysial portion of right ramus of lower jaw, small, and of young animal, no teeth; has three mentary foramina in vertical line. 10*a*. Talon and last plate of milk molar. 11. Penultimate upper right true molar; found in NW. branch of cave. 12. Last lower molar, found in NW. branch of cave, in colour and mineral condition like No. 11. 13. Fragment of posterior half of last lower molar. 14. Last lower molar; fine specimen from Branch 'A.' 15. Tusk, fragment from near end; found with No. 14. 16. Five ridges of germ of a lower true molar; one intermediate plate wanting to make pieces fit correctly. 17. Anterior fang portion with two ridges of true molar, upper jaw, probably antepenultimate. 18. Middle portion of another true molar, probably antepenultimate. 19. Middle portion, comprising two ridges of germ of lower true molar. 20. Posterior portion of upper molar in germ state, comprising two ridges and talon, and showing marks of gnawing. 21. Another portion of posterior molar, more weathered. 22. Mutilated fragments of a *larger sized molar* than any of the others.'

2. *Vertebræ of Elephas Melitensis.*

'*College of Surgeons, July* 27, 1860.—Examined the small vertebra of the Elephant from Zebbug, and compared it with the fourth, sixth, and ninth vertebræ of a young Indian Elephant. None of these have the spinous processes so much reclined, or continued in the same plane as the oblique surfaces. In the somewhat cordate shape of the spinal opening, and in the proportion of the posterior costal depression contributed by the transverse processes and centrum, it agrees best with the ninth; but in the fossil the bridge between the anterior and posterior depressions is not so broad. The transverse processes are not quite so transverse as in the fourth and sixth, but are much less inclined upwards than in the ninth. The anterior articulating processes are near together, and the intervening circular sinus is less marked than in the fourth and sixth; in this respect the fossil closely resembles the ninth. The sinus between the posterior costal cup and the posterior oblique processes, seen sideways, is deep and marked exactly as in the ninth; in the fourth and sixth it is open and shallow. The posterior oblique articulating surfaces are approximated as in the ninth, and not wide apart as in the sixth, or still more in the fourth; but there is a raised ridge between them, and not a hollow, as in the fourth, sixth, and ninth. The general form of the body of the fossil is somewhat cordate as in the ninth, and the keel below the body is very much as in the ninth. If the specimens in the College Museum are properly numbered, the fossil is a vertebra intermediate between the sixth and ninth, and is most probably the eighth; the spinous processes at its base being much more like the ninth than the sixth. The dorsal vertebra of the Zebbug Elephant closely resembles in form that figured in Eichwald's paper "De Pec. et Pachyd. reliq. fossil," (Nova Act. Acad. Nat. Curios., vol. xvii. part 2, p. 160. Tab. LIV. figs. 3 and 4.), and referred by him to *E. proboletes*. The latter,

however, is about twice as large as the Malta fossil, but in the former the vertebral foramen is much larger in proportion.' (See Pl. XIII. figs. 1 to 4.)

[Among Dr. Falconer's drawings there is a representation of another vertebra of *Elephas Melitensis*, which was identified as the seventh cervical, and which has been already referred to. See *antea*, p. 251, note.—ED.]

3. *Pelvis of Elephas Melitensis.*

'Among the fossil remains from Zebbug there is also the right side of a pelvis which agrees in the closest manner possible, so far as the acetabulum goes, with that of the Indian Elephant in the College of Surgeons Museum.' (See Pl. XIII. figs 5 and 6.)

4. *Humerus of Elephas Melitensis.*

'*College of Surgeons, July* 21, 1860.—The humerus from Zebbug is the left, and agrees most closely with that of *Elephas Indicus*, No. 2654, which has not the epiphyses synostosed. All the leading points of general form are exactly the same. It also agrees most closely with the detached humerus, No. 2741 B., the chief difference being the two lengthened depressions near the outer angle at the top, which are much more pronounced in the fossil. Unluckily the head is gone in the fossil, or the evidence would be complete. Although belonging to a nearly adult individual, its entire length is not more than ten inches.' (See Plate XIV. figs. 1 to 5.)

5. *Femur of Elephas Melitensis.*

'*College of Surgeons, August* 14, 1860.—Examined the repaired shaft of the Zebbug Proboscidean femur, and compared it with that of Choonee's skeleton.[1] The general resemblance is excessively close. There is the same bridge between the epiphysis of the head and of the trochanter; there is also exactly the same deep fossa (like a foramen) below the epiphysis of the trochanter, in both; and the same general form of the lower end. But the following differences are seen:—

'1. The hollow descending, on the *posterior* side of the fossil below the trochanter, is much more pronounced.

'2. The hollow in front (running in same direction) which is so great in fossil is entirely wanting in the existing Elephant.

'3. The edges of the base of the trochanter are more angular and pronounced in fossil.

'4. The outer edge, below middle of the shaft, is quite sharp in existing species, but much rounder in the fossil.

'5. On the inner side behind, leading to the condyle, there is a longitudinal fossa in the fossil, which is wholly wanting in the existing Elephant; but the outer posterior sides are alike.

'6. The foramen of medullary artery in the fossil is exactly as in the femur of Mammoth in the case in the British Museum; in Choonee's skeleton it is situated on the inner side, in a line contiguous with projecting part of head.' (See Pl. XIV. figs. 6 to 10.)

'*British Museum, August* 9, 1860.—Examined a transverse section from the middle of the shaft of the broken Zebbug left femur. The centre is a compressed flattened hollow tube, the inner surface of which

[1] See *antea*, p. 268.—[ED.]

is not smooth, but rugged and cancellated. Outline of section is ovoid. Greater diameter of shaft, 1·2 in.; lesser ditto, at middle, ·85 in. Greater diameter of hollow tube, ·53 in.; lesser ditto, ·33 in.'

6. *Fossil Halitherium, from Malta.*[1]

'*British Museum, December* 20, 1862.—Compared the fossil from Malta, having three teeth, with *Listriodon* and *Halitherium*. In *Listriodon* the ridges very much as in Tapir; outside in the upper jaw they are nearly vertical, and the outer point high, with clean transverse ridges. Further, in *Listriodon*, the ridges of the upper teeth wear obliquely in front, the apex being intact, as in *Dinotherium*; while in the lower jaw the wear is reversed. In the Malta fossil the wear is horizontal.

'The last tooth agrees very closely with figs. 16, 19 and 20 of Plate 1 of Kaup's "Beiträge," on *Halitherium*. As compared with the skull, the molars of the latter are much worn and very Hippopotamine-like in the discs of wear. The fossil evidently is not of *Listriodon*, but of the *Dugong* family.

'The cancellar tissue of the bone is very open in the fossil, as in the *Cetacea*.'

7. *Notes upon the Zebbug Specimens. March* 1862.

'Regarded as a whole, they differ in character from the Crendi specimens, and appear to belong to an entirely different set of animals. The most interesting of these are a series of Elephant molars, referred to in Captain Spratt's paper, as being of Mammoth. They consist of molar teeth of all ages, from the first milk molar to the last, and many of them are of remarkably small size. Three of them appear to be the last true molar, lower jaw; of these, one, No. 14, is nearly entire, showing nine plates much worn, and the posterior talon. No. 13 (see list at page 302), also a back molar, has the grinding plane of the crown of the tooth scooped and obliquely distorted from being worn all on one side. Two of the larger upper molars are nearly entire; one of them, No. 11, is quite entire. *There is also one very mutilated fragment of a molar indicating a specimen of a larger size.* Among these Elephantine specimens there is a fragment consisting of the anterior portion of the right ramus of the lower jaw. There is also a fragment of a tusk about 4½ in. long, and nearly 1 in. in diameter, comprising the terminal portion near the point. Besides the entire molars there are eight or ten fragments of molars consisting chiefly of plates which had not been cemented. One weathered specimen of ivory indicates an individual of very considerable size. The next most interesting amongst the specimens are the humerus and femur of a Proboscidean form of a very peculiar character (*Elephas Melitensis*). To this form also appear to belong a pelvic portion containing the acetabulum, a dorsal, and a lumbar vertebra, besides the body of a vertebra, denuded of the processes. Belonging to *E. Melitensis* there is also the shaft of a very small humerus, without epiphyses, evidently of a young animal.

'Of Elephantine remains there is also a fragment of the anterior portion of the lower jaw, comprising simply the symphysial por-

[1] This fossil was not obtained from the caves. It was purchased for Capt. Spratt from a collector, and was probably obtained from the Miocene deposits of Malta.—[ED.]

Fig 1

Fig 5

Fig 2

Fig 3

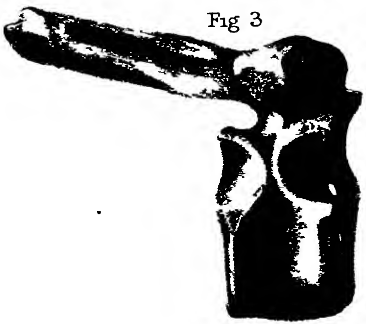
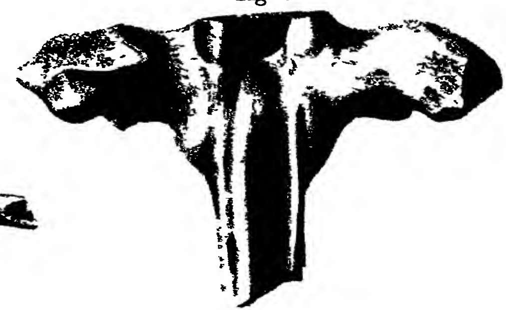


Fig 6

Fig 4



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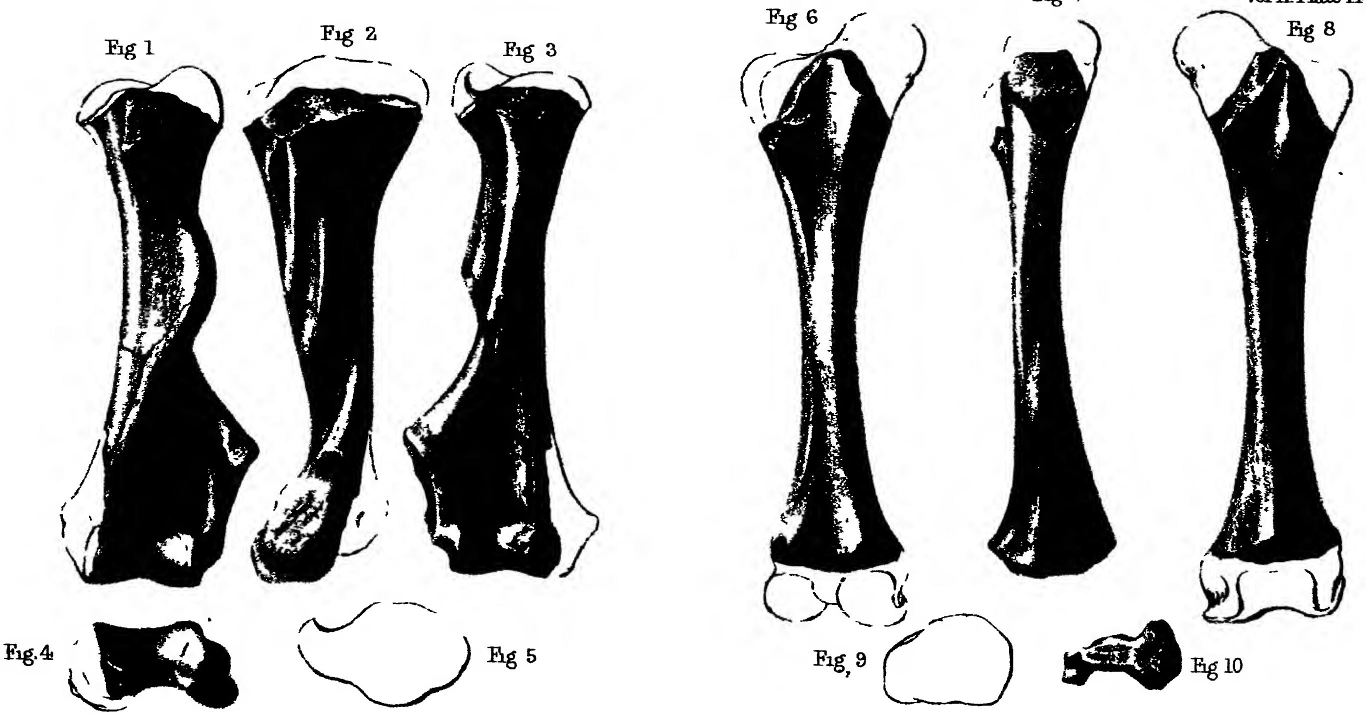


J.Dinkel del et lith.

Elephas Melitensis

W West imp.

tion, the ridges bounding the gutter of the spout and the two mentary holes, but much too mutilated to indicate the age or give any determinable character.

'There is also what appears to be a residuary portion of the smooth ball of the humerus of an Elephantine form, but very much mutilated and weathered; also the iliac portion of a pelvis and three fragments of the cranium of an Elephant, so inferred from the presence of large diploe-cells. Among the other fragments are a metacarpal or metatarsal bone of a pachyderm, the size of a large Tapir, also a scapula, with the articular cup and spinous process nearly perfect; also a phalangeal bone apparently of a Proboscidean. Fragments of spinous processes of vertebræ, both dorsal and lumbar, some of them indicating animals of a very considerable size, as large at least as *Bos primigenius.* Besides the mammalia, there are various fragments of the carapace and plastron of two Chelonian forms, one of them of small size, and indicated by small fragments; there are some leg bones without articular surfaces, apparently belonging to the same forms. Further amongst the collection there is a series of specimens which bear very distinct marks of having been gnawed by a large carnivorous animal. The tooth marks upon some of these are very boldly pronounced. From among these, nine principal specimens have been selected; one a cylindrical bone, is the most pronounced; another is the gnawed and detached globular head of a femur, about 1¾ in. in diameter, and another apparently the head of a humerus. Many of the darker specimens exhibit distinct marks of minute superficial burrowings or excavations, which Mr. Rupert Jones tells me have been detected even in grave-bones by Professor Henslow. It is not a little remarkable that amongst these numerous indications of gnawing by a large carnivore, there is not a single indication of what that form was. The core, with some enamel-inequalities of one tooth was found, but with no part of the crown remaining, and therefore wholly undeterminable. It would agree, in size, with the carnassier tooth of a large Hyæna, but it is too mutilated to guess even at the order to which the form belonged.

'A number of sharks' teeth were found in the clay among the fossils from the Zebbug Cave; these are the only objects that might possibly have been used by man, no fragments of flint having been found in the cavern. These teeth probably fell out from the yellow sandstone deposit in which the cave occurs, and in which similar teeth are frequently found.'

8. *Notes of Captain Spratt's Collection of Fossil Bones from Crendi Cavern, Malta. (Mahlek Cave of Adams.)*

'*Geological Society, March* 18, 1862.—The principal mass of the collection consists of a very hard, compact, calcareous matrix, and fragments containing solitary molars, fragments of molars of tusks and incisors of *Hippopotamus Pentlandi.* They appear all to belong to a single species *Hipp. Pentlandi.* About a dozen of the specimens, comprising fore molars and back molars, are tolerably perfect; they were compared with some of Baron Anca's specimens from Olivella, and others found by myself in the Maccagnone Cave, with which they agree entirely. Some of the molars agree with the larger Sicilian form of the same cave and of the caves near Palermo. These have been put up

apart for reference. There are also some fragments of tusks and incisors, but none of them sufficiently perfect to figure.

'Besides these there is a series of amorphous fragments of bone, variously splintered, and, therefore, indeterminable, and three determinable specimens, No. 14 being the half of the head of a humerus, divided vertically through the middle, the fractured surface clean, flat, and smooth, as if effected through a fault-displacement. Another is the articular end of a radius, and the third the basal part of the spinous process of a vertebra.

'Next are three slabs of very compact dark grey-coloured stalagmitic matrix. No. 1 contains in strata a great many small fragments of the teeth and bones of a minute mammal; the molar teeth belong to a large extinct species of Myoxus (*Myoxus Melitensis*, Falc.).

'There is also one very large rodent incisor with various fragments of ribs, the end of an ulna, &c. One very beautiful molar of *Myoxus* shows the crown distinctly.

'These remains are confined to the upper layers of the matrix, through which they are very profusely dispersed; the compact portion of the stalagmite, about $1\frac{1}{2}$ in. thick, is devoid of fossils, or nearly so, and the weathered surface would indicate that this is the upper surface of the deposit.

'Slab No. 2 is of the same character, but the fragments of bones contained in it are less perfect. It contains also one fine molar of *Myoxus* presenting the crown-surface.

'Slab No. 3 is remarkable in showing the greater part of the shaft of what appears to be a femur, but undeterminable from being crushed at the articular ends.

'Besides these there is a quantity of detached and weathered minute fragments, inferred to belong chiefly to *Myoxus*; of determinable fragments amongst these are a molar, part of a jaw, a metacarpal, or metatarsal, and a phalangeal bone.

'One specimen consists of a small canine or outer incisor of a carnivorous animal, of the size of the Fox. The above includes all the specimens deserving notice.

'The carnivorous tooth here referred to is the only indication of a feline form being contained amongst the whole of the Crendi specimens.

'So far as the comparison has been carried, the Crendi specimens differ entirely from those found in the Zebbug Cave.'

9. *Additional Note on the Fossils from Zebbug and Mahlek Caves.*

'*Geological Society*, *July* 10, 1862.—Memorandum of supplementary despatch received from Captain Spratt yesterday.—A box containing a mixed collection of fossil bones from the newly-discovered cave, called by Captain Spratt the *Hippopotami Cave*, together with a small box containing numerous fragments, mostly small, and supplementary to his previous despatches. Among these are numerous fragments of bird-bones; 2nd, fragments of carapace, &c., of Chelonians; 3rd, a large quantity of fragments of ribs and other bones of mammalia, mostly undeterminable; 4th, a tin box containing fragments, more or less perfect, of small molars of Elephants; and lastly, a pill-box containing an undoubted tooth of a carnivore, but of small size, being the first carnivorous indication in the shape of a tooth from the Zebbug Cave.

'The great mass of the specimens contained in the box consist of fragments of the extremities of a small species of Hippopotamus, the most important of which are lower articular ends of femurs, lower ends of humeri, and some of tibiæ. The bones are for the most part in a very fragmentary condition, and much weathered or rolled. The articular surfaces, as a general rule, are abraded or more or less mutilated; one fine specimen consists of the shaft of a femur with the trochanter present, but the articular head unluckily broken off and not yet discovered in the collection; the lower portion has the articular condyles broken off by an ancient fracture. It is not quite clear, therefore, whether the bone belonged to an adult individual or not; but it indicates a smaller species than *Hippopotamus Pentlandi*, or any of the other Hippopotamus remains sent previously by Captain Spratt. This, however, will require further and more careful observation. Besides these fragments of the bones of the extremities there have been picked up by Captain Spratt, in a separate compartment, about a dozen molars, some of them very perfect; the worn last molars with their talons indicating a species of unusually small size, thus corresponding with the indications yielded by the bones of the extremities. There are also some fragments of incisors and some good specimens of inferior canines, all of which will have to be compared with the corresponding teeth from the Maccagnone and San Teodoro caverns, belonging to Hippopotamus.

'*Memo.*, *July* 31.—The molars and canines appear mostly to be of the small species, *Hipp. minutus*, Cuv.'

III.—Abstract of Communication by Dr. Falconer to the British Association at Cambridge, on October 6, 1862, entitled 'On Ossiferous Caves in Malta, explored by Captain Spratt, C.B., R.N., with an Account of Elephas Melitensis, a pigmy species of Fossil Elephant, and other remains found in them.'

Reprinted from 'The Parthenon' for October 18, 1862, p. 780.

'The author's notice of this interesting discovery was prefaced by a few remarks from Captain Spratt, explanatory of the former geographical connection of the islands of Sicily and Malta with the African continent, as evidenced by their contained fossils and by the shallow soundings which lay between these coasts and that continent. Three caves in Malta had yielded vast numbers of Mammalian bones of very dissimilar character. The first, discovered while quarrying for a dock, contained vast quantities of Hippopotamus bones, and was similar to a cave previously discovered in Crete. The second, lying upon the side of a ravine, three hundred feet above the sea, was partly filled with clay and Elephant bones; the third contained bones of Hippopotami, associated with remains of a large species of Dormouse.

'Dr. Falconer, after corroborating the divisional line pointed out by Captain Spratt, which, now represented by a line of roadway of shallow water, formerly existed as a belt of land, dividing the Mediterranean into two basins, and pointing out that the fossil fauna of Italy, Sicily, Malta, and Crete, was that of the African and not of the European continent, proceeded to describe the fossil remains new to science which Captain

Spratt's investigation had produced. The pigmy Elephant was an animal of remarkably small proportions; an adult individual could not have exceeded the Indian Tapir in height and bulk, a creature not much larger than a full-grown Hog. Contrasted with the bones and teeth of an adult African Elephant the difference in size of these portions of its frame exhibited were most striking.[1] But though so small, the skeleton agreed in every particular with the one of greatest bulk. A series of harmonies ran through the two skeletons, one bone answering to another truly, and without ordinal or generic difference. The author could refer it unhesitatingly to his subgenus *Loxodon*, in the African group of Elephants. Captain Spratt's researches had brought to light many bones, tusks, and teeth, belonging to the young of this pigmy species; the milk-teeth being about half an inch in length, and the tusks corresponding in age not exceeding an inch in length. *Myoxus Melitensis*, the fossil Dormouse, the remains of which had been found in the Crendi Cave,[2] was as much a giant among the Dormice as the Maltese Elephant was a dwarf. Other fossil remains found in these remarkable caves were referable to two species of Swan: one of colossal size, probably thrice as large as the bulkiest living species. Many of the bones were gnawed, apparently by a powerful feline animal, but no remains of the carnivore had yet been discovered in association with the cave contents.'[3]

[1] The specimens exhibited comprised the molars, tusks, lower jaw, vertebræ, scapula, humerus, pelvis, femur, metatarsal bones, and phalanges.—[Ed.]

[2] See pages 300 and 305.—[Ed.]

[3] See page 306, last line.—[Ed.]

V. ON THE EUROPEAN PLIOCENE AND POST-PLIOCENE SPECIES OF THE GENUS RHINOCEROS.[1]

After examining all the collections in England and Italy and those of Lyons, Montpellier, &c., I have come to the conclusion that there were four distinct Pliocene and Post-Pliocene species of Rhinoceros, three of which have long been confounded by Cuvier and other palæontologists under the name of *Rhinoceros leptorhinus*. I have carefully examined at Stuttgart the materials on which Kaup's and Jäger's *Rhinoceros Merckii* is founded. It is not a distinct species, but is identical with the Grays Thurrock species, or *Rhinoceros leptorhinus* (*mihi*). The *R. Lunellensis* of Gervais is founded on a young jaw with milk-dentition, which is not to be depended on for determining distinctions. So, also, the *Rhinoceros elatus* of Croizet, and the *R. mesotropus* of Aymard, found in Auvergne, are not distinct species. I have examined the chief collections in Auvergne. The specimens in M. Pichot's collection and in the Museum of Le Puy are mainly *R. Etruscus*, while the *R. mesotropus* of Aymard comprises both *R. leptorhinus* and *R. antiquitatis*. The four species may be classified as follows :—

Pliocene.

I. *No bony nasal septum.*

1. Rhinoceros leptorhinus (Cuv. *pro parte*).
   Syn. R. megarhinus of Christol.

II. *Partial bony septum.*

2. Rhinoceros Etruscus (Falc.).
   Syn. R. leptorhinus (Cuv. *pro parte*).
3. Rhinoceros hemitœchus (Falc.).
   Syn. R. leptorhinus (Owen *pro parte*).

Post-Pliocene.

III. *Complete bony septum.*

4. Rhinoceros antiquitatis (Blumb.).
   Syn. R. tichorinus (Fischer and Cuvier).

[1] The introductory remarks have been compiled by me from two letters, addressed by Dr. Falconer in 1862 to Mons. Lartet, of Paris, and Col. Wood, of Stout-hall, Swansea, and from his note-books. The important essay on *Rhin. hemitœchus* was written in 1859, but is now for the first time published. The notes on *Rhin. leptorhinus*, including the lengthened description of the Cortesi cranium at Milan, on *Rhin. Etruscus* and on *Rhin. antiquitatis*, are extracted from the author's note-books.—[Ed.]

1. *Rhinoceros leptorhinus.*—This is the original and typical *Rhinoceros leptorhinus* of Cuvier, founded on Cortesi's Monte Zago cranium. It is the species described by Christol as *R. megarhinus*, and is the only Pliocene or Post-Pliocene European species that had not a nasal septum. To this belongs the celebrated Cortesi cranium in the Museum at Milan, which I have carefully examined. With this species also I have identified the Rhinoceros remains found in the Sub-Apennine beds of Piacenza, in the Val d'Arno upper beds, at Montpellier and Lyons, and at Grays Thurrock in Essex. The Rhinoceros, however, found in the Elephant-bed of the Norfolk coast is different.

2. *Rhinoceros Etruscus.*—This species, like the following, had an incomplete bony nasal septum, but it had a comparatively slight and slender form. It is met with, along with *Elephas* (*Loxodon*) *meridionalis* and *Mastodon Arvernensis*, in the lower beds of the Val d'Arno, and in the 'Submarine Forest-Bed,' or super-imposed blue clays of the Norfolk Coast, immediately underlying the boulder-clay; but, as yet, it has been found in none of the ossiferous caves of Britain. With this species, also, I have identified the remains of a Rhinoceros submitted to me by Professor Ansted, which were found a few miles from Malaga, in white marl, overlying Pliocene blue clay abounding with shells.

3. *Rhinoceros hemitœchus.*—This species has been described by Professor Owen as *R. leptorhinus.* It has the nasal septum incomplete in the centre, and it differs from *R. antiquitatis* (*R. tichorinus*) in other cranial characters, as well as in those of the teeth. I am satisfied on this point, after examining the entire dentition of both young and old animals. *Rhinoceros hemitœchus* accompanies *Elephas antiquus* in most of the oldest British bone-caves, such as Cefn, Durdham Down, Minchin Hole, and other Gower caverns. It is also found at Clacton in Essex (*e.g.* The 'Clacton Rhinoceros'), and in certain beds in Northamptonshire. It is also met with in Italy.

From some of these localities, entire skulls and a great portion of the skeleton have been obtained.

4. *Rhinoceros antiquitatis* (*R. tichorinus*).—This species had a complete bony nasal septum. It is found in the newer Pliocene deposits of Kent, Surrey, and Essex, and associated with *Elephas primigenius* in caverns of the same date. *Elephas antiquus* with *Rhinoceros hemitœchus*, and *Elephas primigenius* with *Rhinoceros antiquitatis*, though respectively characterizing the earlier and later portions of our period, were probably contemporary animals; and they certainly were companions of the cave-bears, cave-lions, and cave-hyænas, and of some at least of the existing mammalia. There can be no

reasonable objection to the name *Rhinoceros antiquitatis*. South of the Rhine, that is in Geneva, France, and Italy, all modern palæontologists call the species *Rhinoceros tichorinus*; but, north of the Rhine, in Germany, Holland, Scandinavia, and Russia, the most eminent authorities designate it *Rhinoceros antiquitatis*. A name in science ought not to be a disputed point of mere geographical predilection. Blumenbach named it first *Rhinoceros antiquitatis*. Fischer de Waldheim, a palæontologist of no great authority, changed the name into *Rhinoceros tichorinus*, and Cuvier adopted Fischer's name without acknowledgment. Desmarest called it *Rhinoceros Pallasii*. Blumenbach's names of *Elephas primigenius* and *Mastodon Ohioticus* are now accepted by everyone; and there is no reason why his *Rhinoceros antiquitatis* should be rejected for a more modern name. Living neither north nor south of the Rhine, I have no geographical predilections, and as an impartial foreigner I accept the earliest name, viz. Blumenbach's; besides, the name *Rhinoceros tichorinus* is faulty, inasmuch as three species had a nasal septum.

I.—On Rhinoceros hemitœchus, an extinct species prevailing in the Gower Caves, South Wales.[1]

In two previous communications (Quart. Journ. Geol. Soc. for Nov. 1857, and vol. xiv. p. 81),[2] I have attempted to trace the distribution of the fossil Proboscidea, with some of their constant associates, in the newer Tertiary deposits of England, and in corresponding deposits on the continent of Europe. One important branch of the inquiry concerns the fossil remains of the ossiferous caves; but my examination of the cave-collections was not, at the time, sufficiently extended to warrant well-founded conclusions on the subject. I had seen undoubted evidence of the occurrence of *Elephas antiquus* and *Hippopotamus major*—both Pliocene forms—in several of the English caverns; but I was in doubt regarding the associated fossil species of Rhinoceros. Since then I have had opportunities of examining most of the great cave-collections in the metropolitan and provincial museums, and of investigating, on the spot, the conditions under which the remains were associated in several of the most productive caverns. Some of the results appear to be of sufficient interest to warrant my bringing them before the Society,[3] although with less detail of evidence, and in a more restricted form, than the nature of the case might seem to demand. But the general subject is so extensive in its relations as hardly to

[1] The MS. of this essay was found among Dr. Falconer's papers, and is now for the first time published.—[Ed.]

[2] See *antea*, pp. 1 and 76.—[Ed.]

[3] The paper was evidently intended for presentation to the Geological Society.—

be susceptible of being embraced within the scope of a single communication; and the remarks which follow the descriptive details forming the special subject of this essay will be confined to the association, in some of the ossiferous caverns in England, of the remains of certain of the fossil mammalia, which I regard as positive indicators of the age of Pliocene deposits, without reference to the altered physical conditions of the caves at different periods, or to the agencies by which the remains were introduced within them.[1]

I may premise that my inquiries have embraced an examination, more or less detailed, of collections from the following caverns:—Kent's Hole, Oreston, and other South Devonshire caves; Banwell, Bleadon, Hutton, Berrington, &c., in the Mendip Hills; Paviland, Spritsail Tor, Minchin Hole, Bacon's Hole, and Bosco's Den, in the peninsula of Gower, in South Wales; Cefn, in North Wales; Kirkdale and Wirksworth. The museums which have been visited in search of materials are the British Museum and those of the College of Surgeons and Geological Society, in the metropolis; and in the provinces, Oxford, for Dr. Buckland's very extensive and classical series of cave-remains from British and foreign localities; Bristol, for the interesting collection from Durdham Down, formed and described by Mr. Stutchbury; Taunton, for the collection amassed during many years by the Rev. D. Williams, from Bleadon, Hutton, and others of the Mendip Caverns; Torquay and Plymouth, for Kent's Hole and Oreston; Swansea, for the Gower Cave collections; and York, for that from Kirkdale. I have further had the advantage of examining the private cave-collections of the veteran Mr. Wm. Beard, at Banwell, from the Mendip caverns; of Miss Talbot, at Penrice Castle, from Paviland; and, above all, the unrivalled collection formed at Stout Hall, by my friend Colonel E. R. Wood, F.G.S., during the last nine years, from the ossiferous caves of Gower. This last has furnished more materials for the description of the extinct Rhinoceros, which is the special subject of this paper, than all the rest together.

Rhinoceros hemitœchus.[2]—The species to which I have assigned this name (for reasons which will more fully appear in the sequel) is, avowedly, not a new accession, except by name, to the Fossil Fauna of Britain. It has long been familiar to geologists as the *Rhinoceros leptorhinus* of Cuvier, according to Professor Owen, and described at great length

[1] This portion of the essay was never written; but the subject will be found treated in the author's paper, 'On the Ossiferous Caves of Gower.'—[Ed.]

[2] From ἥμισυς, half, and τοῖχος, partition, in reference to the partial nasal septum, distinctive of the species.

in the 'British Fossil Mammalia.' I have arrived at the conclusion that it is essentially distinct from the original *Rhinoc. leptorhinus* of Cuvier, which latter, however, I believe occurs in England, in beds, in some respects different from those in which *Rhinoc. hemitœchus* prevails, and to a certain extent, with different associates. In this view, the exact identification of the two species becomes in its geological bearings a question of much higher importance than the mere rectification of a specific name. Before entering on the descriptive details, it will be necessary to revert to the origin of the name *Rhinoc. leptorhinus*, and to trace the successive opinions which have been entertained by palæontologists regarding it up to the present time; for there is not, within the whole range of Mammalian Palæontology, an extinct species regarding which more has been written and more opposed views advanced.

The great French anatomist, having conclusively demonstrated the distinctness of the Siberian Rhinoceros from all the species then known, framed his diagnostic character upon the most obvious of its peculiarities, namely, the ossified nasal septum, and designated it '*le Rhinoceros à narines cloisonées*,' or *Rhinoceros tichorhinus*. His attention was naturally awakened to the probability of other species occurring in the fossil state, in which the nasal septum would be found to agree with existing species, in presenting the ordinary condition of an unossified cartilage. Cortesi had discovered in 1805, upon Monte Zago, near Piacenza, the entire skull, in fine preservation, of a fossil Rhinoceros, which he referred with doubt to a young *Rhin. bicornis*.[1] A drawing of this cranium, by M. Adolphe Brongniart, and thus carrying high authority with it of a competent execution, was many years afterwards forwarded to Cuvier from Milan. The figure represented a cranium differing essentially in form and proportions from that of the Siberian Rhinoceros, and most obviously in the absence of the bony partition of the nostrils, characteristic of the latter. Cuvier inferred that the Italian form constituted a different species, which, in contradistinction, he named '*le Rhinoceros à narines non-cloisonées*,' or *Rhinoceros leptorhinus*. The specific distinctions which he indicated for the latter were, that the cerebral part of the skull was proportionally shorter than in the Siberian form, and less projected backwards over the occiput; the position of the orbit above the fifth molar; the termination of the nasal bone by a free point having no connection with the intermaxillaries through a bony partition; and the abbrevia-

[1] Saggi Geologici, p. 72, tab. vii.

tion and different form of the intermaxillaries. To these cranial characters he added more slender proportions in the general construction of the skeleton, inferred from Val d'Arno specimens which he attributed to the same species; and he held that the Italian fossil form approached more nearly to the *Rhinoceros bicornis* of the Cape than to any other known species. He appears to have considered that it had been invested with two horns. Upon the characters of the molar teeth he furnished little beyond what was merely conjectural; for, having founded his conception of the species mainly upon the characters furnished by Cortesi's skull, without examining the molars in that specimen, he took it for granted that all the lower jaws, molars, and other remains, occurring in Italy, which did not admit of identification with *Rhinoc. tichorhinus*, must of necessity belong to his *Rhinoc. leptorhinus*. The subject was not at the time sufficiently advanced, nor the materials in sufficient abundance, to lead him to conjecture that there might have been two or more Italian fossil species different from the Siberian form. But there are now the strongest grounds to believe that such is the case; and that Cuvier, as in the similar instance of *Eleph. primigenius*, *Eleph. antiquus*, and *Eleph. meridionalis*, confounded the remains of at least two Italian fossil species of *Rhinoceros* under the common designation of *Rhinoceros leptorhinus*.

Rhinoceros leptorhinus, as thus defined by Cuvier, met with ready acceptance among palæontologists, and remained undisputed until the year 1834, when M. de Christol,[1] in a very able and elaborate memoir 'On the Characters of the Large Species of Fossil Rhinoceros,' broadly asserted that this supposed species had no existence in nature, and that Cortesi's cranium belonged to the Siberian form, *Rh. tichorhinus*. Christol, like Cuvier, had not an opportunity of examining the original, which in the interval had suffered considerable injury by fracture of the facial portion; but, having received from Milan fresh drawings of the specimen thus altered in appearance, he erroneously interpreted as a bony septum a shaded representation of the internal surface of the nasal cavity of the left side of the head, viewed from the right side, where the corresponding part was mutilated. Dr. Cornalia, of Milan, so late as 1853, submitted Cortesi's cranium to a rigid examination, specially with a view to the determination of this point, and states in the most positive terms that there is not a trace even of the supposed bony septum: 'Cette cloison n'existe nullement. La voûte de la cavité nasale ne présente, le long de sa ligne médiane, aucun prin-

[1] Annales des Scienc. Nat. 1835, 2me Sér. tom. iv. p. 44.

cipe de cloison descendante qui aurait pu être détruite. Enfin je suis sûr, et je vous assure que le crâne que nous conservons n'appartient pas au *R. tichorhinus*, et qu'on a eu tort de confondre les deux espèces. Le regard de M. Cuvier était bien plus perçant et tombait plus justement dans le vrai.'[1] Christol erased *Rh. leptorhinus* from the list of fossil species, and at the same time proposed the name of *Rhinoceros megarhinus* for the remains of a two-horned fossil species occurring in the Pliocene Sands of Montpellier, and characterized by the great length of the nasal bones; by the short interval between the nasal sinus and the orbits; by the slight elevation of the pyramid of the vertex above the plane of the brow; by the inconsiderable inclination of the occipital plane, which is abruptly truncated at the vertex; by the relative position of the orbits, and by peculiarities in the teeth. Marcel de Serres had previously endeavoured to distinguish the same form under the name of the 'Fossil Rhinoceros of Montpellier' (*Rhinoceros Monspessulanus*, De Blainv.); but gave way to the dissent expressed by Cuvier, who identified it with his '*Rhinoceros à narines cloisonées.*' Christol was further led to the conclusion that the *Rhinoceros incisivus* of Cuvier was identical with his *Rhinoc. megarhinus.*

From a remark by Laurillard, it would appear that at a later date Christol was convinced that his opinion respecting *Rhin. leptorhinus* was erroneous; but no formal expression of this altered view having been published, the objections which he had raised continued for a considerable time to influence the opinions of palæontologists.

Croizet and Jobert, in 1828, described and figured remains of a *Rhinoceros* from Puy-de-Dôme, which from its general slender proportions they designated *Rhinoceros elatus.* No perfect cranium of this form has as yet been discovered in the Velay; and the jaws and teeth at present known are not sufficiently pronounced to determine with certainty whether *Rhinoceros elatus* is distinct, or to what nominal species it ought to be referred. De Blainville identified it with the Miocene *Rhinoceros incisivus*! Laurillard doubted whether it ought to be referred to *R. megarhinus* or to *R. leptorhinus*; Pomel refers it to his *Atelodus elatus*, which includes *Rhinoc. elatus*, together with *Rhinoc. megarhinus* of Christol; and Gervais hesitatingly refers it, together with Owen's form of

[1] The first authoritative correction of Christol's statement was made in 1842, by Professor Balsamo Crivelli, the curator of the Museum of Santa Teresa in Milan, where the specimen was preserved. He states, that the supposed partition was absolutely wanting, and explains the cause of the mistake. But the correction escaped the notice of European Palæontologists until 1853, when Dr. Cornalia of Milan, at the request of Duvernoy, re-submitted the Cortesi cranium to a rigid examination.

Rhinoceros leptorhinus from Clacton, also to *Rhinoceros megarhinus.*[1]

Jäger, in 1839, proposed the provisional name of *Rhinoceros Kirchbergense* for certain remains discovered in sand-pits in the pleistocene ('Diluvial-boden') deposits of Kirchberg in Wurtemberg. The materials were limited to one lower and two detached upper molars; and the comparison of them was confined to corresponding teeth of *Aceratherium incisivum*, of the *Rhinoceros tichorhinus* occurring at Cannstadt, and of the two-horned Rhinoceros of the Cape. No attempt was made by Jäger to distinguish the Kirchberg form from the *leptorhine* Rhinoceros of Cuvier, the *R. elatus* of Croizet, or the *R. megarhinus* of Christol.[2] The name proposed by Jäger has therefore strictly no claim to be regarded otherwise than as a conjectural determination; and at a later period he abandoned it, having adopted the opinion of Owen, that the Kirchberg Rhinoceros was identical with the supposed *Rhinoceros leptorhinus*, discovered at Clacton, as described in the 'British Fossil Mammalia.'

In 1841 Kaup brought out, in the 'Akten der Urwelt,' his description of the same nominal species, but under the new designation of *Rhinoceros Merckii* of Jager, who, at the instance of his friend Kaup, consented to the substitution of this specific name, both as less open to objection on the score of local derivation, and as a tribute to the memory of Merck, its earliest indicator, who, towards the close of the last century, made the first important step towards the distinction of the Mammoth from existing species. Kaup collected additional materials from various localities in the valley of the Rhine, and extended their comparison, beyond what was attempted by Jager, to supposed remains of the *Rhinoceros leptorhinus* of Cuvier. The conclusions at which he arrived were, that *Rhinoceros Merckii* was a distinct species, of the size of the two-horned Rhinoceros of the Cape; that it belonged, jointly with *Rhinoceros Africanus* (*R. bicornis*) and *Rhinoceros leptorhinus* of Cuvier, to a particular division of the genus, characterized by the form of the molar teeth and the absence of incisors; and that it had been a contemporary of the Mammoth, *Rhinoceros tichorhinus*, *Rhinoceros leptorhinus*, and other forms of the so-called Diluvial Period.[3]

The next step of importance in the history of *Rhinoceros*

[1] It was subsequently referred by Dr. Falconer to *Rhin Etruscus*.—[Ed.]

[2] The lower jaw, in the reference to fig. 6, tab. xvi., is attributed by Jager to *Rhin. tichorhinus.*

[3] In his last work (Beiträge, 1 Heft. p 4), Kaup gives up *Rhin. Merckii* for *Rhin. leptorhinus.*

leptorhinus dates from the publication of the 'British Fossil Mammalia' in 1846, when Professor Owen brought out his elaborate and detailed description of the remarkable cranium and other remains discovered at Clacton, in Essex, by our veteran Associate, Mr. John Brown, of Stanway. The skull in question is chiefly notable from its presenting the well-marked appearance of an incomplete bony partition connecting the anterior half of the nasal bones vertically with the osseous floor of the nasal cavity. (See Plate XV.) When the specimen first came under the inspection of Mr. Owen, he was induced to refer it, on account of this septum, to the '*Rhinoceros à narines cloisonées*,' or *Rhinoc. tichorhinus* of Cuvier, and it is quoted as such in his Report to the British Association in 1843. But when submitted to a more rigorous examination, at a subsequent period, the practised eye of this eminent palæontologist detected in it important points of difference irreconcilable with *Rhinoceros tichorhinus*; and having faith in the accuracy of the confidently-expressed, but erroneous conclusions of Christol, respecting the presence of a septum in Cortesi's cranium, he was naturally led to identify the Clacton skull with the *Rhinoceros leptorhinus* of Cuvier. This conviction was strengthened by the examination of a ramus of the lower jaw, also found by Mr. Brown in the same deposit at Clacton, which Professor Owen concluded was identical with lower jaws from Tuscany, referred by Cuvier to his *Rhinoceros leptorhinus* (Oss. Foss., tom. ii. Pl. IX. figs. 8 and 9); and with the lower jaw from the Rhine, referred by Kaup to *Rhinoceros Merckii*. The Clacton, Tuscan, and Rhenish specimens were included under the common designation of *Rhinoceros leptorhinus*.

The great weight of Professor Owen's authority was evinced in the accounts given by other palæontologists of *Rhinoceros leptorhinus* after 1846. De Blainville, in his 'Ostéographie,' although at variance upon some points of detail, admitted the Clacton skull into his limitation of *Rhinoceros leptorhinus*, with which he combined the Rhinoceros of Montpellier, of Marcel de Serres, and the *Rhinoc. megarhinus* of Christol. But he eliminated the Rhenish materials, referred by Jäger and Kaup to *Rhin. Merckii*, and referred them to *Rhinoceros incisivus*, being in his view the male of the Miocene *Aceratherium incisivum* of Eppelsheim! This portion of De Blainville's palæontological labours has met with severe strictures from some of his own countrymen, and with stern condemnation by Kaup.

Laurillard, in 1849, in his revision of the Fossil Species of Rhinoceros, presents *Rhinoceros leptorhinus* in a manner which attempts to combine the irreconcilable conceptions of

Cuvier and of Owen. He admits the partial bony septum described by the latter, and even concedes three fossettes to the upper molars, as in *Rhin. tichorhinus*, excepting only the last true molar; while he attributes to it the slender proportions inferred by Cuvier, and assigns for its habitat Italy and the Pliocene formations of England. Laurillard admitted also *Rhin. megarhinus* of Christol, or *Rhin. Monspessulanus* of De Blainville, as a distinct species. He refused to accept the *Rhin. Merckii* of Jäger and Kaup, and the *Rhin. elatus* of Croizet he regarded as referable either to *Rhin. megarhinus* or to *Rhin. leptorhinus*.

Gervais has devoted much study to the fossil species of Rhinoceros, occurring in the Pliocene and Post-Pliocene deposits of Auvergne and the South of France. The results are embodied in the 'Paléontologie Française.' He adopts the *Rhin. megarhinus* of Christol, yet although that species is described by all original observers, himself inclusive, as devoid of a bony septum, he considers it probable that the Clacton cranium figured by Professor Owen as of *Rhin. leptorhinus* belongs, notwithstanding its septum, to that form. On the other hand, he doubtingly admits the *Rhin. leptorhinus* of Cuvier as a distinct species, occurring in Italy and the Velay. He has applied the designation of *Rhin. Lunellensis* to the remains of a species discovered in the Cave of Lunel-viel, first named *Rhin. minutus* by Marcel de Serres, Dubrueil, and Jean-jean, under a mistaken interpretation of the age of the teeth, and at a later date described as being identical with the *Rhin. Africanus.* He has repeatedly directed the attention of palæontologists to the important fact, that this fossil species of Lunel-viel is hardly, if at all, distinguishable from the existing two-horned Rhinoceros of the Cape.

Pomel, in his 'Catalogue,' published in 1854, after a study of the remains occurring in Auvergne and the Velay, admits *Rhin. leptorhinus* with a bony nasal septum, as defined by Professor Owen, but under the designation of *Atelodus leptorhinus*; and gives for its habitat England, the Milanese, and the valley of the Rhine. Under another name, *Atelodus elatus*, he includes the *Rhin. elatus* of Croizet, and the *Rhin. megarhinus* of Christol. A third species, exclusive of *Rhin. tichorhinus*, he designates *Atelodus Aymardi*, and refers to it, as a synonym, the *Rhin. leptorhinus* of Gervais.

Duvernoy, the successor of Cuvier and De Blainville in the chair of Comparative Anatomy, attempted a revision of the Fossil Species of Rhinoceros, in a very elaborate memoir published in 1854. In the section devoted to the Pliocene species, he maintains, with many details, that the *Rhin.*

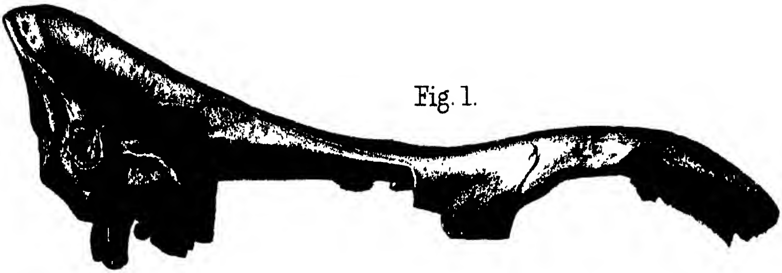
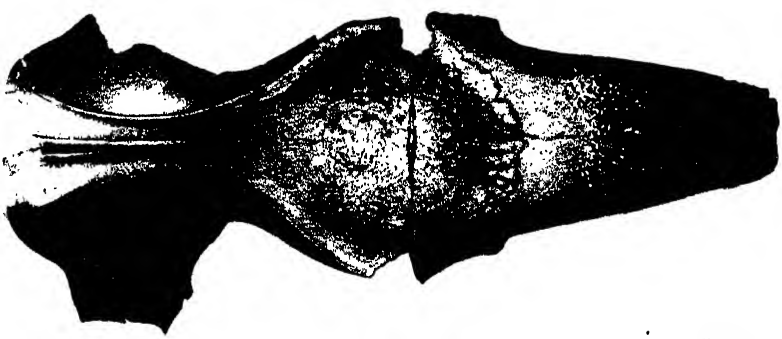


Fig. 1.

Fig. 2.

Fig. 3.



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Rhinoceros hemitoechus.

(The Clacton Skull.)

leptorhinus, as established by Cuvier, was a sound species; and that Cortesi's cranium was entirely devoid of a bony septum, according to the positive evidence of Dr. Cornalia. To this *Rhin. leptorhinus* he refers the *Rhin. megarhinus* of Christol, and the *Rhin. Monspessulanus* of Marcel de Serres. He regards the Clacton cranium, described by Professor Owen, as wholly distinct from *Rhin. leptorhinus*, and, although still different, as being more closely allied to *Rhin. tichorhinus.* He proposes for it provisionally the specific designation of *Rhin. protichorhinus*, as an independent form. Not the least remarkable result of Duvernoy's inquiries was, that he identified, as certainly belonging to *Rhin. tichorhinus*, the representations figs. 8 and 9, Pl. IX. of the 'Ossemens Fossiles,' which Cuvier adduced as typical illustrations of the lower jaw of *Rhin. leptorhinus*, from specimens found in the Val d'Arno; and upon which Professor Owen mainly relied, in identifying the lower jaw from Clacton with the latter species! A more signal illustration could not be adduced of the diametrically opposite conclusions which may be drawn by different palæontologists from the same evidence, when presented in the form of imperfectly executed figures.

Lastly, Brandt, in his very complete and valuable monograph of the Rhinoceros of Siberia, published in 1849, reviews the figures and description of the Clacton skull given by Professor Owen, and expresses the opinion that it does not belong to *Rhin. leptorhinus*, but to an individual of *Rhin. tichorhinus*, in which the septum was not completely ossified. He gives a representation of a Siberian instance of this nature, corroborating the cases previously cited by Pallas and Collini.

In order to show at a glance the range and fluctuation of opinion on this palæontological question, it may be useful to summarize them in a few words:—

1. 1812. *Rhinoceros tichorhinus*, established by Cuvier as characterized by its bony nasal septum.
2. 1819. The 'Rhinoceros of Montpellier' (*Rhin. Monspessulanus*, De Blainv.), proposed by Marcel de Serres as a distinct form; identified by Cuvier (1822) with *Rhinoc. tichorhinus*; tacitly abandoned by De Serres.
3. 1822. *Rhinoceros leptorhinus*, proposed by Cuvier upon Italian specimens as destitute of a bony septum.
4. 1828. *Rhinoceros elatus*, of the Velay, proposed by Croizet and Jobert.
5. 1834. The absence of a bony nasal septum in Cuvier's *Rhinoc. leptorhinus*, denied by De Christol; the name regarded as a synonym, merely, of *Rhinoc. tichorhinus.*
6. 1834. The 'Rhinoceros of Montpellier,' reproduced by De Christol under the name of *Rhinoc. megarhinus*, as identical with

Rhinoc. incisivus of Cuvier, but distinct from *Rhinoc. tichorhinus* and from the supposed *Rhinoc. leptorhinus.*

7. 1838. *Rhinoceros primigenius*, proposed by Bronn, in the 'Lethæa Geognostica,' to include the *Rhinoc. tichorhinus* and *Rhinoc. leptorhinus* of Cuvier, in conformity with the views of Christol.

8. 1839. *Rhinoceros Merckii* (syn. *Rhinoc. Kirchbergense*, Jäg.) proposed by Jäger (1839), and by Kaup (1841), as a distinct form.

9. 1842. *Rhinoceros de Filippi*, proposed by Balsamo Crivelli, for remains occurring in the Lignite of Leffe (Gandino) as distinct alike from *Rhinoc. tichorhinus* and *Rhinoc. leptorhinus.*

10. 1846. *Rhinoceros leptorhinus* of Cuvier, reproduced by Owen upon British fossil specimens, but invested with a bony septum, and *Rhinoc. Merckii* identified with it; *Rhinoc. megarhinus* or *R. Schleiermacheri*, held to be distinct.

11. 1847. *Rhinoc. leptorhinus* admitted by De Blainville, as *with* or *without* a bony nasal septum; *Rhinoc. megarhinus* combined with it; but *Rhinoc. Merckii* transferred to *Rhinoc. incisivus.*

12. 1849. *Rhinoc. leptorhinus* of Cuvier, accepted by Laurillard, in the view of Owen, as having a bony septum; *Rhinoc. megarhinus* of De Christol held to be distinct.

13. 1849. The *Rhinoceros leptorhinus* of Cuvier accepted by Brandt, but the *Rhinoc. leptorhinus* of Owen identified with *Rhinoc. tichorhinus* (!).

14. 1852. Undecided opinions entertained by Gervais, who adopts the *Rhinoc. megarhinus* of De Christol, and leans to the view that the *Rhinoc. leptorhinus* of Cuvier, founded on Cortesi's cranium, and of Owen, are of the same species; but that the Rhinoceros remains of the Velay (*Rhinoc. elatus*, Cuv.) and of the Val d'Arno belong to another distinct form.

15. 1854. *Rhinoc. leptorhinus*, adopted by Pomel, in the view of Owen, as having a bony septum, under the name of *Atelodus leptorhinus*; and another species, besides *Rhinoc. tichorhinus*, proposed under the name of *Atelodus Aymardi*, as also having a bony septum; the *Rhinoc. elatus* of Croizet, identified with *Rhinoc. megarhinus*, under *Atelodus elatus.*

16. 1854. The *Rhinoceros leptorhinus* of Cuvier, reproduced by Duvernoy as destitute of a bony septum; *Rhinoc. megarhinus* identified with it; and the *Rhinoc. leptorhinus* of Owen erected into *Rhinoc. protichorhinus.*

The above table suggests a grave and instructive comment on the uncertainty of palæontological determinations, even when guaranteed by names of the highest authority. The point upon which hinged the discussion, protracted during upwards of twenty years, was, 'Had *Rhinoc. leptorhinus* an osseous nasal septum, or had it not?' The pendulum oscil-

lated between septum and no septum. The array of authorities on either side was nearly balanced, with the exception of a discreet few headed by De Blainville, who followed the convenient *via media* and argued that the character was of little importance, being but a degree, more or less, of ossification of the nasal cartilage, and that, according to circumstances of age, sex, or vigour in the species, might, or might not, have had the partition ossified. Considering that the cranium upon which Cuvier relied has been deposited during nearly half a century in one or other public museum in Milan, on the high road of continental travel, it might have been expected that the disputed point would have been speedily settled by an appeal to the original specimen. But until the appearance of Crivelli's evidence in 1842, confirmed by Cornalia in 1854, the Cortesi cranium, upon which the case rested, does not appear to have been examined by any one of the numerous palæontologists all over Europe who took a share in the dreary discussion.

It will be admitted that an essay to determine with precision a single form, out of such a class of confused synonymy and perplexed opinions, will be of some service to Palæontology. This I shall endeavour to do with the Clacton species, hitherto described under the name of *Rhin. leptorhinus*; and it has appeared to me to be better to give it a new specific name, than to attempt to identify it conjecturally with some one of the names that have already been proposed for forms supposed to be different from the *Rhin. leptorhinus* of Cuvier. The *ad interim* designation, suggested by Duvernoy, for the Clacton species of *Rhin. protichorhinus*, is manifestly inadmissible. Whether *Rhinoceros hemitœchus* may not be identical with some of the materials figured and described by Kaup, under the name of *Rhin. Merckii*, I am unable to determine satisfactorily. The upper molars from Chagny and Crozes, figured by Cuvier, which Kaup refers to that species, differ materially in the form of the 'crochet,' a character of great significance, from those of *Rhin. hemitœchus*. The same uncertainty applies to the *Atelodus Aymardi* of Pomel, from the Velay, so named in his 'Catalogue Méthodique,' but without figures or sufficient distinctive characters to establish the species. *Rhinoceros hemitœchus* certainly differs from *Rhin. leptorhinus* of Cuvier, as founded on Cortesi's cranium, which I have examined, both in the dental characters and form of the skull, and also in the general proportions of the skeleton; and it differs equally from the *Rhinoceros megarhinus* of De Christol, skulls and other remains of which I have examined at Lyons and Montpellier. If the distinctness of the species is established, and its range in time and geographical distribu-

tion over Europe are determined, my object in this communication will have been attained. It is left to systematic writers on Palæontology to decide by what specific designation the form here called *Rhinoceros hemitœchus* shall hereafter be recognized. In the meantime, the name now applied will be of convenience to geologists in dealing with the Mammalian remains of one period of the Caves, and of deposits of the age of Clacton, and certain localities in Northamptonshire as distinct, on the one hand, from the 'Elephant-bed' of the Norwich coast, and on the other, from the superficial gravels of the Glacial period.

My first acquaintance with the species dates from the spring of 1858, when, on a visit to Plymouth, to examine the remains of the Oreston caves, I saw in the possession of Mr. Spence Bate a beautiful drawing (which he liberally placed at my disposal) of a ramus of the lower jaw of a Rhinoceros, discovered by Colonel E. R. Wood in 'Bacon Hole,' which a cursory examination satisfied me differed alike from *Rhin. leptorhinus* and from *Rhin. tichorhinus.* (See Pl. XXI.) On proceeding to Swansea, in company with my friend the Rev. Robert Everest, I compared the original of Mr. Spence Bate's drawing with a fine specimen of a corresponding ramus of the lower jaw of a fossil Rhinoceros, from the Elephant-bed' of the Norfolk coast, belonging to the collection of the Rev. John Gunn of Irstead,[1] which I had previously inferred to be of *Rhinoceros leptorhinus* of Cuvier, as met with in the valley of the Po and the Val d'Arno. In the Museum of the Royal Institution of South Wales at Swansea, besides the specimen in question, I found the right and left rami of another lower jaw, containing on the left side the series of the six posterior molars in beautiful preservation (Pl. XIX.), together with a fragment composing four consecutive molars of the upper jaw, right side (namely the penultimate and antepenultimate true molars, and the two posterior premolars), and likewise some vertebræ and fragments of bones of the extremities. The whole of these remains were discovered in 1850 in the cave of 'Bacon Hole,' in Gower, about six miles west of Swansea, during an exploration carried on by Colonel E. R. Wood, of Stout Hall, by whom they were presented to the Swansea Museum. The character of the upper molars established to a certainty the distinctness of the species. On communicating this result to Colonel Wood, I was informed by him that in another of the Gower Caves, named 'Minchin Hole,' the exploration of which he had undertaken after exhausting 'Bacon Hole,' he had dis-

[1] See *antea*, p. 349.—[Ed.]

covered the entire cranium of an adult Rhinoceros with the series of molars complete on both sides, the nasal bones perfect to their tips, and a well-pronounced partial bony septum connecting the anterior portion of the nasals with the floor of the nostrils. This most precious and unique specimen met with a grievous accident, by which it was crushed and destroyed whilst temporarily out of Colonel Wood's hands; and all that now remains of it is the palate, with the line of molars on either side, which is deposited in the Museum of the College of Surgeons. I found in Colonel Wood's rich collection at Stout Hall a very fine specimen comprising the cerebral part of another cranium of the same species of Rhinoceros, the facial portion of which appears to have been broken and destroyed by the workmen during extrication from the floor of the cavern. This fragment will be described in the sequel.[1]

Colonel Wood, on being made aware of the important nature of the result of his researches, immediately recommenced the operations, which had been temporarily suspended, in 'Minchin Hole,' and discovered a large number of additional remains of the same species. These I had an opportunity of examining on a second visit to Gower during last autumn, and the whole series has been liberally placed at my disposal by Colonel Wood.

My attention was next directed to ascertaining whether the Gower form occurred in any other of the ossiferous caverns in England; and on proceeding to Bristol, I found in the very interesting series of fossil remains, discovered by Mr. Stutchbury, in Durdham Down, several upper molars specifically identical with those of the Rhinoceros of Bacon Hole and Minchin Hole.[2] The same result followed an examination of the Rhinoceros remains from 'Oreston,' near Plymouth, described by Mr. Whidbey in 1817,[3] and now preserved in the Museum of the College of Surgeons.[4] They all proved to belong to the same species. I next instituted a comparison between the upper molars discovered by Mr. John Brown, F.G.S., at Clacton and the Gower specimens, with the same result.[5]

The materials available for the description of the species are therefore very abundant, including specimens, more or less complete, of at least four crania of different ages; five upper jaws presenting the molars in different stages of wear; eleven rami of the lower jaw, young and old; together with fragments of most of the principal bones of the extremities.

[1] See paper on the Gower Caves, and also pp. 350 to 352.—[Ed.]

[2] See Appendix, No. II., p. 349.—[Ed.]

[3] Philosoph. Trans., 1817.

[4] See Appendix, No. IX., p. 353.—[Ed.]

[5] See Appendix, No. V., p. 351.—[Ed.]

With the exception of two of the skulls, all the specimens here enumerated are the products of Colonel Wood's zealous and meritorious researches in the Gower Caves. On the present occasion, I shall confine myself to the description of such specimens only as are essential to establishing the specific distinctness of the form.

Characters of the Molar Teeth.—The crowns of the upper molar teeth in Rhinoceros present a common pattern of great complexity, but subject to modifications in the different species that are very constant, thus furnishing good characters for distinguishing them. Cuvier gave such a clear and complete analysis of the elements that enter into the composition of the crown, and was so happy and simple in the terms by which he designated them, that little was left to his successors besides the application of these terms to the new forms discovered after his time. De Christol followed up and extended the observations of Cuvier with much ability, in his Essay on the European Fossil Species, and succeeded more especially in tracing the peculiarities of character produced by the attachment of the distal end of the 'crochet' to the contiguous parts, or by its remaining free. The other points of principal importance to be regarded are the number of fossettes on the worn triturating surface; the presence or absence of an internal basal bourrelet to the three last premolars; the form of the hind barrel of the last true molar in respect of its being either simple and undivided, as in most of the species fossil or recent, or divided by a posterior figure or fossette, which is so distinctive a character of *Rhinoceros simus*, among the living, and of *Rhinoceros tichorhinus* among the extinct forms; and lastly, the relative thickness of the coat of cement, a character the value of which in the species of Rhinoceros has, in some measure, been hitherto overlooked.

Fig. 1 of Pl. XVI. represents a fine fragment of the upper jaw, right side, belonging to the collection of Colonel Wood. It contains the five last molars in perfect preservation; *i.e.* the penultimate and last premolars, with the three true molars. The antepenultimate premolar (p.m. 2) has been appended in outline, from a reversed figure of the tooth on the opposite side of the same individual. The age and relative stage of wear in the different teeth are such as to present the characters in the most favourable manner. The antepenultimate true molar (m. 1) is so far advanced in wear, that the posterior fossette is reduced to a small oval pit; on the penultimate (m. 2) the detrition is so little advanced, that the same valley is not yet isolated, and the peculiar form of the 'crochet,' which constitutes one of the

Fig. 3.

Fig. 1.

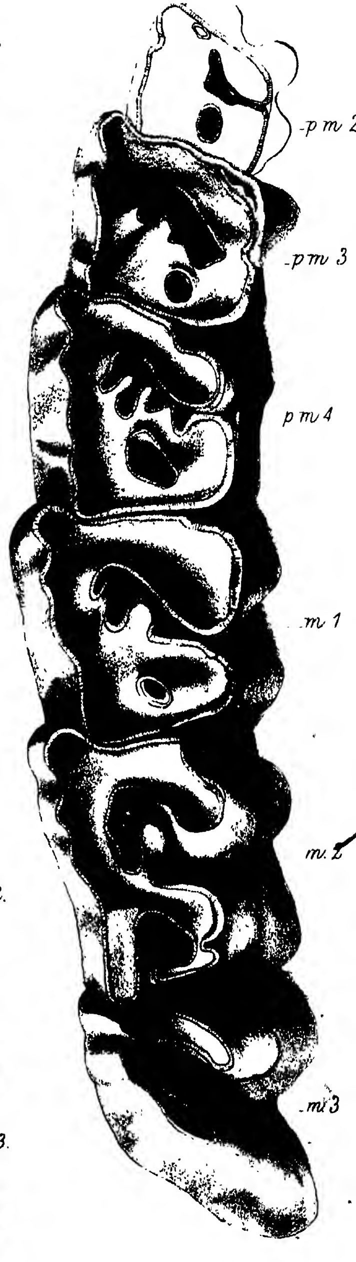
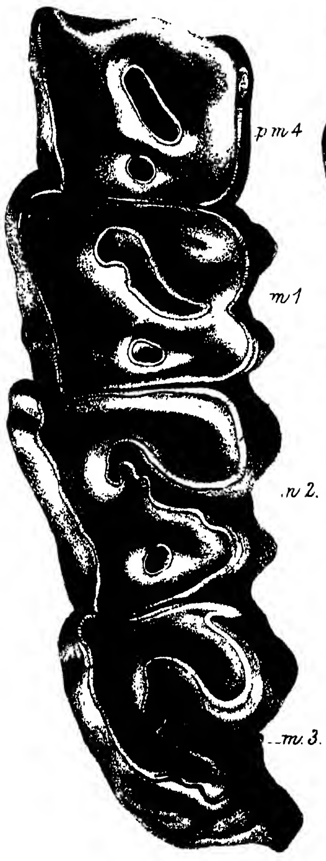


Fig. 2.



J. Dinkel del. et lith. W. West imp.

Rhinoceros hemitœchus.

distinctive marks of the species, is well shown; while the apex of the crown of the last molar had only come slightly into use. The premolars are well worn, and in the normal ratio, to the state of the antepenultimate true molar (m. 1). All the teeth are invested by a very thick coat of cement, which is denuded from the upper part of the anterior barrel of the last molar (m. 3). The specimen was yielded by the last excavations in 'Minchin Hole.'

Fig. 2 of Pl. XVI. represents another fine fragment in Colonel Wood's collection, composing the four last molars, also of the left side of the upper jaw, but considerably more worn, the crowns of the last premolar (p.m. 4) and of the antepenultimate true molar (m. 1) being ground down to a uniform surface, each enclosing two fossettes; while the last true molar (m. 3) shows the various folds of enamel, and the form of the 'crochet' in the stage of abrasion best suited for exhibiting the characters. All the teeth in this specimen also are enveloped by a thick coat of cement. It was yielded by 'Minchin Hole.'

Figs. 1 and 2 of Pl. XVII. represent a fragment of the right side of the upper jaw, containing three consecutive teeth, namely, the last premolar mutilated at the outer surface, and the antepenultimate and penultimate true molars, the latter having the inner side of the posterior barrel fractured. The crowns are in a less advanced stage of wear than in the two preceding specimens, and the last premolar presents a modification in the disposition of the fossettes, to be noticed in the sequel. The specimen belongs to the Swansea Museum, and was discovered by Colonel Wood in 'Bacon Hole.' The enamel in all the teeth is invested with a very thick layer of cement.[1]

Figs. 3, 4, and 5 of Pl. XVII. represent different views of a detached germ of the last true molar, upper jaw, left side, which has not yet come into use. It is free from any coat of cement, thus presenting all the folds and depressions of the enamel-shell in a perfect manner.

Fig. 3 of Pl. XVI. represents a detached penultimate molar of the left side, being the counterpart, from the opposite side, of the tooth (m. 2) represented in fig. 1 of the same plate.

These specimens are all drawn two-thirds or three-fourths of the natural size, and taken together they furnish a complete view of the characters of the upper molars, with

[1] The dimensions of this specimen are given in Dr. Falconer's note-book as follows:—
'Length of three molars, 5·9 in. Length of last molar, outer surface, 2·9 in. Width of ditto, in front, 2·2 in. Length of penultimate, outer surface, 2·2 in. Width of ditto, in front, 2·3 in. Length of last premolar, broken, 1·75 in.'—[Ed.]

the exception of the small and deciduous first premolar, which is rarely seen *in situ.*

Premolars.—The premolars (Pl. XVI. fig. 1, p.m. 2, 3, and 4) in *R. hemitœchus* belong to the series indicated by Cuvier, in which there are only two fossettes produced by wear on the grinding surface. The antepenultimate (p.m. 2) presents a nearly square crown; and the median termination of the transverse valley is reduced to a triangular fissure, which on the inner side is not quite isolated, the anterior and posterior divisions not been ground down sufficiently to efface the intervening cleft. The posterior valley is isolated and reduced to an elliptical fossette.

The penultimate premolar (p.m. 3), as is usual in the genus, presents a sudden and very considerable increase of size beyond the antepenultimate. The inequalities of the crown are worn down to a common plane, the middle of which is occupied by a large and irregular fissure, being the isolated termination of the middle valley; and a round fossette indicates the remains of the posterior valley. The hinder boundary of the middle fissure forms a flexuous edge composed of two projecting rounded lobes, being the remains of a bifid 'crochet.' Several small tubercles are seen rising up from the bottom of the fissure.

The last premolar (p.m. 4) is presented in three different stages of wear by the different specimens. In the 'Bacon Hole' fragment (Pl. XVII. figs. 1 and 2), the abrasion of the crown (p.m. 4) is so little advanced that the posterior valley is not yet isolated; the anterior and posterior barrels are separated by a wide and deep valley, which is nearly straight and of uniform width. Its posterior boundary is undulated, but free from any considerable projection directed from the posterior towards the anterior barrel. A portion of the termination of the middle valley is already detached, forming a third fossette. This, however, is an individual variety, that is not uncommon in either the penultimate or last premolars of species which have ordinarily but two fossettes. It occurs occasionally in the premolars of *R. bicornis*, and Gervais has figured an instance of the same kind occurring in a premolar of *R. megarhinus*. The portion of the crown corresponding with the outer or longitudinal ridge is broken off, in this specimen; but the loss does not interfere with the principal character.

A more advanced stage of wear and a different pattern are seen in the same tooth (p.m. 4) as presented by fig. 1 of Pl. XVI. The posterior valley forms a large detached oval fossette. The inner side of the crown is worn so low that the barrels are almost confluent, and the commencement

Fig 1

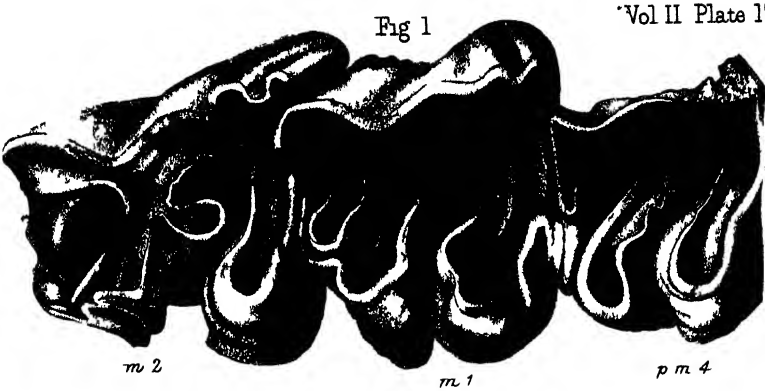


Fig 2

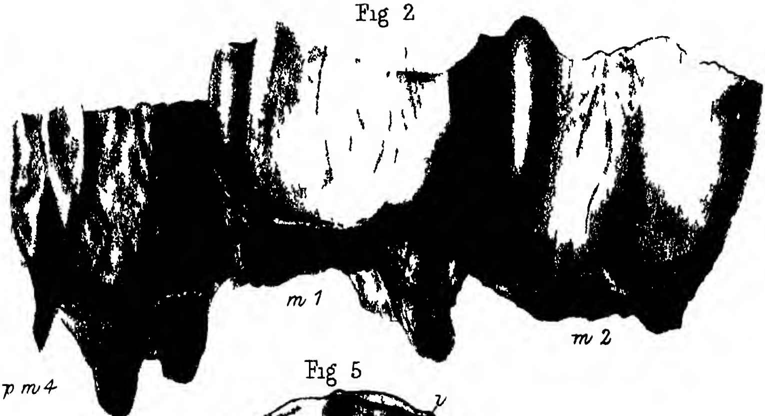


Fig 5

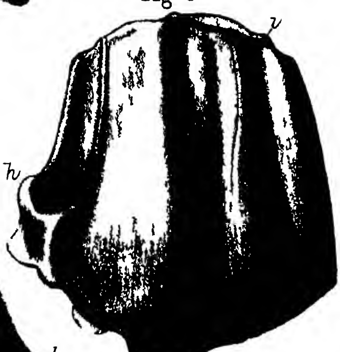


Fig 3

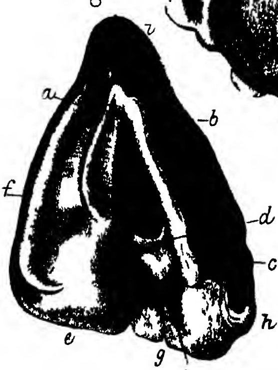
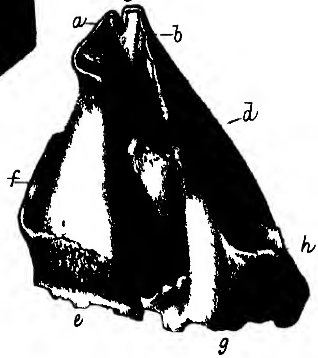


Fig 4



J. Dinkel del et lith

Rhinoceros hemitœchus

of the middle valley nearly effaced. The central fissure forms a very irregular chasm deeply indented by the salient processes of a bifid 'crochet' thrown off in front of the posterior fossette, and by a thick projecting plate given off from the middle of the longitudinal outer ridge and converging towards the top of the crochet. If during the further progress of wear the points were to run together into a common surface, a third detached fossette would be formed, exactly as is seen in the preceding specimen, and the anterior border of the posterior colline would present only a slight amount of undulation, instead of the numerous salient plates or denticulations yielded in its present state. These processes are less conspicuous in the penultimate premolar (p.m. 3), in consequence of its more advanced stage of wear, which has led to their disappearance; but the two lobes of the bifid 'crochet' are distinctly discernible in the latter tooth.

A third condition of the last premolar is furnished by the anterior tooth (p.m. 4) of Pl. XVI. fig. 2. Here the abrasion of the crown has proceeded so far that the transverse valley is reduced to a diagonal excavation, oblong in form, with rounded ends and parallel sides. The enamel boundary of this fossette is perfectly smooth and equal, the projecting processes of the bifid 'crochet' having entirely disappeared; and the posterior valley is reduced to a small round pit. On the inner side the waste of the crown by grinding has gone so far that no indication remains of its having been originally composed of two distinct barrels.

These three examples furnish an instructive series of illustrations of the very different patterns which may be presented in this species by the same tooth in different stages of abrasion. In each case the tooth is fortunately in place in the jaw in connection with other molars, which determine its rank and numerical position with certainty. Had they been found detached it would have been but conjectural to identify p.m. 4 of fig. 2 (Pl. XVI.) with the complex crown of p.m. 4 in fig. 1 (Pl. XVI.).

I have seen other detached premolars of *R. hemitœchus* from various localities, all presenting the same characters, that is to say, the hind barrel projecting into the central fossette a bifid 'crochet,' and an accessory parallel plate emitted from the middle of the outer or longitudinal ridge, forming together three 'combing plates' of a complex pattern, as in p.m. 4 of fig. 1 (Pl. XVI.). Two specimens of this nature, from the cavernous fissure of Durdham Down, are preserved in the Bristol Museum. They are contiguous premolars of the upper jaw, left side.[1]

[1] See Appendix, No. II., p. 350.—[Ed.]

Another character of much importance, as a specific distinction, is that the premolars of the Rhinoceros of the Gower Caves are constantly devoid of an internal basal bourrelet.

Having regard to the various points above indicated, the premolars of *R. hemitœchus* may be characterized :—

1. By the absence of an internal basal bourrelet.
2. By there being two fossettes only to the worn crowns.
3. By the middle valley being traversed by the processes of a bifid crochet emitted from the posterior barrel, and by a parallel combing plate given off by the outer or longitudinal ridge.
4. By being invested, like the true molars, with a very thick coat of cement.

The presence of only two fossettes instead of three at once distinguishes these premolars from those of *Rhin. tichorhinus*, while the absence of a basal bourrelet, besides other characters, distinguishes them from *Rhin. megarhinus* and *Rhin. leptorhinus*. Among existing species, *Rhin. bicornis* resembles the Gower fossil form in the bifid crochet and combing plate which project into the 'cul de sac' of the middle valley; but it differs materially in the strongly developed crenated bourrelet, which encircles the inner side of the premolars.

De Christol has figured two varieties of the last upper premolar in *Rhin. megarhinus*, in one of which (fig. 10 of Pl. III.) there is a very pronounced basal bourrelet, while the other (fig. 4 of Pl. III.) is entirely free from it (Pl. XVIII. figs. 1 and 2 of this work).[1] The teeth correspond so exactly in every minute detail of pattern in other respects, that it is impossible to doubt that they are of the same species. The tooth, fig. 4, agrees also with the last premolar of *Rhin. hemitœchus* (p.m. 4 of fig. 1, Pl. XVI.), in the absence of a bourrelet, in the 'crochet' being bifid, and in emitting a single combing plate from the outer ridge. But on instituting a minute comparison, the following points of difference are discernible. In the premolars of *Rhin. megarhinus* and also of *Rhin. bicornis* the 'combing plate' (R. of figs. 10 and 4 of De Christol) is emitted in a line with the anterior outer angle, and converges diagonally to meet the plane of the crochet (T.) nearly at a right angle; and the

[1] Annales des Sciences Nat 2me Sér tom. IV. Zool In Dr F's MSS the figures cited from De Christol are 'figs 25 and 19,' which correspond to figs 10 and 4 in Pl. III of the memoir in the 'Annales des Sciences,' there being seven figures in Pl. I, eight in Pl. II., and fifteen in Pl. III. The latter figures, moreover, correspond with copies which Dr. F. had made from those numbered 25 and 19. These figures have been reproduced in figures 1 and 2 of Pl. XVIII. of this work.—[Ed.]

processes of the bifid crochet do not project much into the valley. On the other hand, in *Rhin. hemitœchus*, the 'combing plate' (p.m. 4 of fig. 1 of Pl. XVI.) is given off from the middle of the longitudinal or outer ridge, and is directed forwards nearly parallel to the upper lobe of the crochet; and both these processes jut more into the valley and are more massive. These alleged points of difference may be regarded as minute and fine-drawn, but they have appeared to me to be constant, and to run through the whole series of the molars.

I do not consider it necessary, on the present occasion, to extend the comparison of the premolars of the Gower Rhinoceros with those of other species.

True Molars.—The distinctive characters of the teeth in this species are still more pronounced in the upper true molars. Fig. 3 of Pl. XVI. represents a detached penultimate of the left side, in the most favourable stage of wear to show the characters. The posterior valley, not long isolated, forms an irregular triangular pit with sloping walls. The transverse valley at its commencement also forms a triangular fissure with the apex pointing to the sinus between the posterior barrel and the crochet; the valley next bends forward in a sigmoid curve, and is very much contracted by the advance of the crochet towards the anterior barrel; and it then expands into a rounded cul de sac, the extremity of which points backwards. During the progress of wear the two valleys never form more than two fossettes, in the manner exhibited by m. 1 of fig. 2 (Pl. XVI.), which presents the antepenultimate or first true molar in a very advanced stage of abrasion. This character, as in the case of the premolars, at once distinguishes the molars of *Rhin. hemitœchus* when found detached from those of *Rhin. tichorhinus.*

But the character which best distinguishes them from all other species lies in the peculiar form of the 'crochet,' or promontory projected forward from the posterior colline into the transverse valley. In all the species, fossil or recent, excepting *Rhin. hemitœchus*, the crochet forms a plate which is emitted at a very open angle with the posterior colline, and directed more or less diagonally towards the anterior outer corner of the crown. This is well seen in the figures given by Cuvier in the 'Ossemens Fossiles.'[1] Pl. V. figs. 1, B. C., and Pl. II. fig. 3, B. of that work exhibit the character in the unicorned Rhinoceros of Java, where the margin of the crochet is continued nearly in a straight line with the anterior margin of the posterior colline. The same is seen in the penultimate B. of fig. 1, Pl. XVIII., representing the

[1] Éd. 3me tom ii *Rhinoceros*.—[Ed.]

adult dentition of the two-horned Rhinoceros of the Cape. For the other existing species, the beautiful figures given by De Blainville in the 'Ostéographie' may be referred to generally in illustration of the same character. In *Rhin. tichorhinus* the crochet is given off at a very open angle, and is united with the 'combing plate' of the outer ridge, so as to form the third fossette; the same occurs in the molars of *Rhin. simus*, which in their general plan bear a close affinity to those of *Rhin. tichorhinus*. In regard to the other fossil species, there are but few specimens figured in the 'Ossemens Fossiles' that can be referred to in illustration. The molar from Chagny (Département du Saône et Loire), Pl. VI. fig. 6, cited by Kaup, as an illustration of his *Rhin. Merckii*, is far advanced in wear, but what remains of the 'crochet' exhibits the same very open angle in its offset from the posterior barrel. Of the two molars from Crozes (Départ. du Gard), also cited by Kaup as of *Rhin. Merckii*, and adduced by Professor Owen as identical with his *Rhin. leptorhinus* of Clacton, the specimen fig. 5 of Pl. XIII. is ground down so low that the crochet has nearly disappeared, and it is therefore hardly a suitable case for comparison; but if it is compared with m. 2 of fig. 2, Pl. XVI. of the accompanying illustrations, being a penultimate of *Rhin. hemitœchus* which is nearly in a corresponding state of abrasion, it is manifest that in the former the curve of the crochet forms a much less abrupt flexure than in the latter. The second Crozes specimen (Oss. Fossiles, *Rhin.*, Pl. XIII. fig. 4) is an abnormal case, the nature of which has been clearly explained by De Christol, in which the crochet is so produced as to be concrete with the middle of the anterior colline, thus leading to the early isolation of a third fossette, in a manner different from what occurs, as an ordinary condition, either in the true molars of *Rhin. tichorhinus* or in any other known species. But although so little worn, that the posterior valley is not yet isolated into a fossette, if the figure given by Cuvier is compared with fig. 3 of Pl. XVI. of the accompanying illustrations, it will be seen that the anterior edge of the posterior colline does not form an acute angle and a re-entering niche with the base of the crochet.

Of the European fossil forms from the Pliocene and more recent deposits, *Rhin. megarhinus* is that of which the dentition is best known, after *Rhin. tichorhinus*. The excellent descriptions and figures supplied first by De Christol, and afterwards by Gervais, leave little to be desired in regard to the cranial and dental characters of this species. In fig. 5, Pl. III. of his memoir (reproduced in Pl. XVIII. fig. 3), De Christol has given a fine illustration of the natural size

of a penultimate upper molar, of which the crown is but slightly abraded, and the 'crochet' well developed. In this case, also, the crochet forms, at its offset, a very open angle with the disc of the posterior colline. In fact, it is continued in nearly the same line of diagonal as the latter, and points to the anterior outer corner of the crown. Gervais (Paléontologie Français, Pl. II. fig. 5) has given a beautiful illustration of an upper molar (penultimate or antepenultimate) of the same species, yielding precisely the same characters (reproduced in Pl. XVIII. fig. 4); and I have, through the kindness of M. Gervais, had an opportunity of examining a considerable number of molars of the same species in the Museum of the Faculty of Sciences at Montpellier, which presented a constant agreement in the offset of the crochet from the posterior colline, at a small inclination only.

If on the other hand the penultimate true molar in *Rhin. hemitœchus* (Pl. XVI. fig. 1, m. 2, and fig. 3) be examined, the crochet (*a*) presents a thick massive body thrown straight forward, and forming an acute angle with the anterior margin of the posterior barrel. It is flat or concave above, and convex below; narrow at the base, and thickening to a blunt margin. In mass it bears a much larger proportion to the disc of the hind barrel than in most of the other species. The distal extremity is closely approximated to the anterior barrel, but always remains detached, undivided, and free from the hooked inflection, so common in the other species, which suggested the name applied to this body by Cuvier. The pattern presented by the stage of abrasion seen in fig. 3, Pl. XVI., may be compared to a boot of which the disc of the hind barrel forms the leg, and that of the 'crochet' the foot. In the corresponding molars of *Rhin. megarhinus* already cited, namely fig. 5 of Pl. III. of De Christol's memoir (reproduced in Pl. XVIII. fig. 3), and fig. 5 of Pl. II. of Gervais' Paléontologie (reproduced in Pl. XVIII. fig. 4), besides the difference of alignment in its offset from the hind barrel, the section of the crochet is wedge-shaped, thinning from a broad base to a sharp edge.

In the antepenultimate true molar, m. 1 of fig. 1 of Pl. XVI., the same general characters are presented, but modified by the greater age and more advanced abrasion of the crown. The posterior valley is reduced to an oval pit. The discs of the anterior and posterior barrels occupy much larger areas; the crochet being ground low down is greatly diminished in projection, but it still forms a right angle with the anterior edge of the posterior barrel. The cul de sac of the middle valley is reduced in size, and a 'combing plate' or fold of enamel from the outer longitudinal ridge juts into it, directed

forwards and parallel to the crochet, corresponding with what was described above of the same process in the last premolars. The origin and connection of this 'combing plate' are explained by the mammillary processes seen above the 'crochet' in the terminal expansion of the transverse valley in m. 2 of fig. 1 (Pl. XVI.). These denticuli are connected with the bottom of the fissure and with its outer wall. It is obvious that if the abrasion of the crown were carried a little further they would run together into a continuous plate, which would project into the valley parallel to the crochet, reproducing the pattern seen in p.m. 4 of the same figure, and in the last true molar, m. 3 of fig. 2 (Pl. XVI.). When this occurs a very complex pattern is the result. Cuvier has figured no examples, but in the additions to Vol. iii. of the 'Oss. Fossiles,' he refers to some teeth procured by Mr. Pentland in Tuscany, 'dont la colline postérieure, au lieu d'un seul crochet, en donne plusieurs petits en avant; ce que fait paraître cette colline dentelée vers sa base quand elle commence à s'user.' He adds, 'ce caractère pourra servir à reconnaître cette espèce (referring to *Rhin. leptorhinus*) par ces molaires.' Professor Owen had his attention directed to the same peculiarity in a fossil which he describes 'as the germ of the antepenultimate molar of a *Rhin. leptorhinus* from Grays, in Essex, in which many smaller processes are sent off into the principal valley, in addition to the large promontory,' but he was not disposed to place much stress upon this as a specific character. In *Rhin. megarhinus*, these 'combing plates' are not directed forwards, but converge from the anterior outer angle towards the crochet. I have lately ascertained, by the examination of the cast of a cranium with teeth contained in the Museum at Pisa, that *Rhin. hemitœchus* occurred in the Fauna of the Val d'Arno,[1] and the teeth so briefly yet pointedly noticed by Cuvier in the passage cited above in all probability belonged to this species. In the penultimate (m. 2) of the 'Bacon Hole' specimen (Pl. XVII. fig. 1), although not much advanced in wear, the denticuli of the 'combing plate' have run together and it is projected forwards parallel to the 'crochet,' thus confirming the constancy of the character.

The penultimate and antepenultimate upper true molars differ so little from each other, except in dimensions and some trivial details of proportion, that it is unnecessary to describe

[1] This cranium of a Rhinoceros, with a partial bony septum was subsequently determined by Dr. Falconer to belong to *Rhin. Etruscus* (p. 359). Mention, however, is made in his note-books of a lower jaw of *Rhin. hemitœchus* in the Pisa Museum. The existence of the latter species in Italy is also mentioned in his letter to M. Lartet, already referred to, p. 309.—[Ed.]

them separately. A very advanced stage of abrasion is presented by the antepenultimate or m. 1 of fig. 2 of Pl. XVI. The posterior valley is reduced to a small pit, and the large sinuous transverse valley to a diagonal fossette, from the posterior wall of which every trace of a crochet or of a combing process has disappeared. The penultimate (m. 2) of the same figure, although less worn, has lost the greater part of the mass of the crochet by the waste of abrasion, and the middle valley, in consequence, forms a fissure of nearly uniform width, much reduced in expansion at its extremity.

Next, in regard to the last true molar. Of all the grinding teeth in the genus Rhinoceros, the last true molar of the upper jaw is that which presents the greatest difference of form and the most pronounced characters for distinguishing the species. Fortunately we possess, in the series of the Gower specimens, a complete set of illustrations, showing this tooth in every stage, from that of the intact germ up to the worn crown of the aged animal; and the modifications of form which it presents are so peculiar, and of so much systematic interest when considered in connection with the partial bony septum, that I shall not hesitate to enter into more detail in describing it than in the case of the penultimate and antepenultimate. This is the more necessary, as De Christol, the most original and weighty authority on the subject since the time of Cuvier, has omitted the last molar in his elaborate analysis, under the belief that it yielded no specific characters of importance.[1] In order to make the description clear, it is requisite to refer to the general composition of the crown of a true molar in *Rhinoceros*, as indicated by Cuvier. Taking the penultimate as the type, the crown is nearly rectangular in outline and bounded by four sub-equal sides; the outer and inner, and the anterior and posterior, forming parallel sides of the square. The outer side (*a b* of the teeth B and C of fig. 1 Pl. XLIII.,[2] Cuvier's Oss. Fossiles (supports a longitudinal ridge or colline, from either extremity of which a transverse flexuous ridge is given off at a right angle, forming (*a c*) an anterior colline, and (*b e*) a posterior colline, parallel to each other, but separated by a sinuous transverse valley. The terminations or barrels of these collines constitute the inner side of the square. The anterior side forms a straight unbroken line, and in all the species presents nearly the same uniform character, except in the greater or less amount of development of its basal bourrelet. The posterior side is the most subject to modification. It is shorter than the anterior, deeply notched by an antero-posterior fissure, generally

[1] De Christol, *op. cit.* p. 47

[2] Corresponds to Pl. v. of Rhin. in vol. ii. of 3rd ed. 1825.—[Ed.]

triangular in form, separating the inner hind barrel from the posterior termination of the outer ridge. This fissure forms the posterior valley. All the species of Rhinoceros hitherto described may be ranged under two heads: 1. Those in which the last true molar has a posterior valley; 2. Those in which it is wanting. To the former series belong *Rhin. tichorhinus* and *Rhin. simus*, which further agree in the common character of presenting three fossettes to the worn crown of the last true molar, namely: one fossette, formed by the posterior fissure; the second, caused by the confluence of the crochet with the combing plate intercepting a portion of the transverse valley; and a third fossette, formed by the remaining or open portion of the latter valley. To the second series belong the unicorned and bicorned species of Asia, and the African *Rhin. bicornis*, together with the European fossil species, such as *Rhin. megarhinus*, *Rhin. leptorhinus*, Cuvier, *Rhin. Schleiermacheri*, &c. They all agree in the common character of the posterior valley or fossette being wanting, but are susceptible of being divided into two subordinate series, namely, those in which the last molar presents two fossettes; one formed by the confluence of the crochet with the 'combing plate' intercepting the outer portion of the transverse valley, the other, composed of its open or inner portion. This series is exemplified by *Rhin unicornis* among living forms. The second subdivision includes the forms in which the crochet is free from adhesion to the 'combing plate,' and the crown, during wear, only exhibits a single fossette, namely, the sinuous fissure of the transverse valley. To this series belong the unicorned Rhinoceros of Java, *Rhin. bicornis*, and the majority of the European fossil forms. The last true molar may therefore be presented with one fossette, as in *Rhin. megarhinus* (*vide* Gervais, Paléontol. Française, Pl. II. figs. 6 and 7); with two fossettes, as in *Rhin. unicornis* (*vide* Cuvier, Oss. Fossiles, *Rhin.*, Pl. II. fig. 3); or with three fossettes, as in *Rhin. tichorhinus* (*op. cit.* Pl. VI. fig. 4).

The presence or absence of the posterior or third fossette entails an important difference in the form of the crown of the last molar. When present (*vide* the fig. last cited), the outline of the tooth is still four-sided, although the posterior side is considerably reduced in width, and the separation of the hind barrel from the end of the outer colline is distinctly marked by an intervening fissure. But when the posterior valley is wanting, the outline of the crown becomes triangular; the summit of the anterior transverse colline remains as usual, while the outer colline is directed diagonally inwards and backwards, so as to make an acute angle with the former. The result is that the summit of the crown, instead of being rectangular, is V-shaped, and the posterior transverse colline

is confluent with and undistinguishable from the outer colline, except by the offset of the crochet, and by the round or barrel-shaped termination at the posterior inner angle. Not a vestige even remains of the posterior outer angle. In fact, the hind leg of the V is composed along two-thirds of its length of the outer colline, the remaining third being made up of the posterior transverse colline, with no mark of demarcation between them. No trace of a depression or groove, corresponding with the posterior fossette, is left upon the surface of the enamel. These characters are well shown by the accompanying figures in Pl. XVIII. fig. 7, representing the summit of the crown in plan, and fig. 6, the same from the inner side, in a germ of the last true molar, left upper, of *Rhin. bicornis*, drawn two-thirds of the natural size: (*a*) indicates the anterior colline; (*b*), the longitudinal colline; (*c*), the continuation of the latter, which is the homologue of the posterior transverse colline; (*d*), the crochet; (*e*), the anterior barrel; (*f*), the anterior basal bourrelet; (*g*), the posterior barrel; (*h*), a small tubercle at the posterior inner angle; and (*i*), the vertical groove of the anterior outer angle.

Let us now examine this tooth as it occurs in *Rhin. hemitœchus*. Figs. 3 and 4 of Pl. XVII. represent top and side views of three-fourths of the natural size of an intact germ of the left last molar, corresponding with the figs. 7 and 6 of Pl. XVIII. of *Rhin. bicornis*; and fig. 5, Pl. XVII., gives an erect view of the outer surface. The same letters of indication apply to the different parts. The outline of the crown in plan is triangular, exactly as in the *Rhin. bicornis*; and the ridges (*a* and *b*) meet at an acute angle, yielding the same V-shaped pattern, the outer and the posterior ridges (*b* and *c*) being continued in the same line without interruption; the anterior basal bourrelet (*f*) repeats the form presented in fig. 7, Pl. XVIII., but is more salient. The crochet (*d*) is projected farther forwards across the valley, and when the erect figure, Pl. XVII. fig. 4, is compared with Pl. XVIII. fig. 6, it is apparent that in the former the crochet makes a more acute angle with the posterior barrel. The niche of the anterior outer angle (*a*) is more pronounced, and there is an intercolumnar tubercle (*k*) at the mouth of the valley which is not seen in the African species. This tubercle is also present in m. 3 of fig. 2, Pl. XVI., and strongly developed in the detached specimen, fig. 5, Pl. XVIII., but wanting in m. 3 of fig. 1, Pl. XVI. On the whole there is a very strong general agreement in form between the last true molars of *Rhin. bicornis* and *Rhin. hemitœchus*; the most obvious difference being the considerably greater dimensions of the tooth in the latter.

The transverse valley in *Rhin. hemitœchus* is triangular at

its commencement, as in the penultimate, m. 2 of fig. 1, Pl. XVI., and is then reduced to a narrow cleft by the projection of the free end of the crochet close to the anterior barrel. The continuation of the valley, beyond the crochet, forms an oblong and somewhat angular expansion, rising from the bottom of which a line of denticular points is seen, connected into a plate attached to the outer colline. This 'combing plate' is projected forwards parallel to the crochet, repeating the pattern already described in p.m. 4, m. 1, and m. 2 of fig. 1, and in m. 2 of fig. 3, Pl. XVI. A similar disposition of these denticular points is exhibited in m. 3 of fig. 1 of Pl. XVI. When the crown is ground down by use, the effect is to produce the appearance presented by m. 3 in fig. 2, Pl. XVI. of a double crochet projected across the valley, one of the processes representing the ordinary crochet, and the other the 'combing plate.' The constancy of this character in running through the whole of the molars proves its importance as a mark of specific distinction.

In some cases, the worn pattern of the middle valley is still more complex. A fine example of this is presented by the last true molar of the specimen No. 22,020 of the Palæontological Catalogue, British Museum, purchased of the late Mr. Ball, and reported to have been procured from the fluviatile deposits of the Valley of the Thames. The five posterior molars of the right side are presented in sequence, the last being in full wear; and in this tooth, besides the crochet and 'parallel combing plate,' the termination of the middle valley presents two additional processes; namely, a stout plate projected at right angles to the crochet, from the anterior outer angle, and a short plate emitted from the anterior colline, above the crochet, and directed backwards. The valley, in consequence, presents a pattern of extreme complexity, with plates jutting into it from three sides.[1]

In *Rhin. bicornis*, Pl. XVIII. fig. 7, the valley is of a similar form, but its posterior wall is free from any combing plate, or tendency to a double crochet. In *Rhin. megarhinus* the crochet of the last molar is also single, and emitted at an open angle from the posterior colline. In illustration, fig. 9 of De Christol's plate, and figs. 6 and 7 of Pl. II. of Gervais' Paléont. Franc. may be referred to.

An abnormal condition of the crochet in the last molar of

[1] The specimen here referred to is described in detail in Dr. Falconer's Note-book as '*R. hemitœchus* of Grays Thurrock,' under date Oct. 1858. Even then he noted important differences in the crochet, &c. from the Minchin Hole Molars; and in his letters to M. Lartet and Col. Wood in 1862 (see pages 309 and 310), he includes the Grays Thurrock Rhinoceros under *R. leptorhinus* (*R. megarhinus*). From some of his later notes, however, it would appear that he identified *R. hemitœchus* as also occurring in the lower brick-earths of Grays Thurrock.—[Ed.]

Fig 1

Fig 2

Fig 3

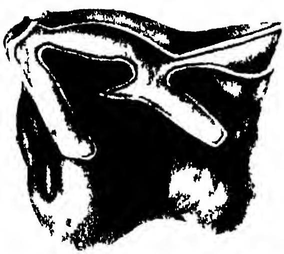


Fig 4

Fig 5

Fig 6

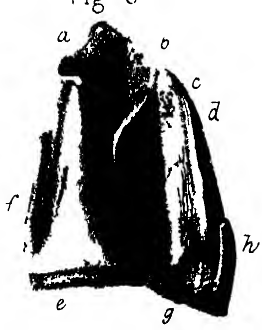
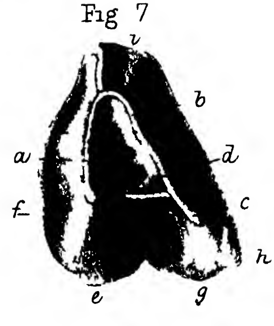


Fig 7



W West imp

1 2,3,4 Rhinoceros leptorhinus (

5 Rhinoceros hemitœchus 6 7 Rhinoceros bicornis

Rhin. hemitœchus is presented by a specimen in the Museum of the College of Surgeons, of which the precise origin has not been recorded, but which is believed to have been procured from Grays Thurrock, or some other of the fluviatile deposits in the Valley of the Thames. It is represented two-thirds of the natural size by fig. 5 of Pl. XVIII. In this case the crochet forms a wall across the valley, insulating its upper portion and connecting the two barrels. It is united to the middle of the anterior colline, and above it, a parallel, short, stout, 'combing plate' juts into the insulated fossette. The general form, angular offset of the crochet, enormous coat of cement, and details of the characters prove it to be of *Rhin. hemitœchus*.[1]

That this peculiar confluence of the crochet with the anterior barrel is abnormal in the true molar is proved by the extreme rarity of the instances which have been observed of it in any species of *Rhinoceros*. Cuvier has figured one (Oss. Foss. *Rhinoc*. Pl. XIII. fig. 4), a penultimate, being the Crozes specimen already referred to (*supra*, p. 330). I have examined, in the Museum of the Faculty of Sciences of Montpellier, other specimens from the Département du Gard, which agreed with the figure of this specimen in every essential respect except the irregular connections of the crochet, and they appeared to me all to belong to the *Rhin. megarhinus* of Montpellier. If the form of the crochet, its offset, and the acute angle which it makes with the posterior colline in m. 2 of fig. 2, Plate XVI., are compared with the same points in the Crozes specimen, the differences are very obvious. No other instance of a bridge-crochet in a true molar has, so far as I am aware, been figured. In the milk molar it is by no means of rare occurrence, and is often seen in those of *Rhin. bicornis*. This appearance must not be confounded with the cohesion between the crochet and the 'combing plate,' which gives rise to the third fossette so characteristic of *Rhin. tichorhinus*.

The most significant peculiarity in the last true molar of *Rhin. hemitœchus* remains to be described. From the marked triangular outline of the crown in plan, and the V-shaped confluence of the terminal ridges, it might have been expected that the posterior fossette would be entirely suppressed, as in *Rhin. bicornis* and other species in the same category. But at the posterior angle of the hind barrel, and dislocated from its ordinary position in the other true molars, a well-defined fossette is placed close to the base of the crown. It is of a triangular form, with a gaping rim, which is deeply

[1] On the drawing of this specimen Dr. F. has written '*R. megarhinus*?'—[ED.]

emarginated behind, and it repeats, but with reduced dimensions, the usual posterior fossette of the penultimate m. 2 of Fig. 1, Plate XVI. The form of this fossette is exhibited by figs. 3 and 4, *h*, and its relation to the other parts by the external view, fig. 5, *h*, of Plate XVII., where a shallow and indistinctly defined channel, bounded on either side by a ridge, is continued upwards upon the enamel-surface from the basal fossette to the apex of the crown, but becoming more and more indistinct as it ascends. This channel is the homologue of the posterior fissure (Oss. Foss., *Rhin.*, Plate VI. fig. 4) in the last molar of *Rhin. tichorhinus* and *Rhin. simus*. On the opposite side of the same figure (fig. 5, *i*) a vertical groove is seen descending from the anterior outer notch. In the last molar of *Rhin. bicornis* (Plate XVIII. fig. 7), the small tubercle (*h*) is the abortive representation of the rim of the posterior fissure of fig. 3, *h*, of Plate XVII.

In consequence of the basal position of the cup of the posterior fissure in the last molar of *Rhin. hemitœchus*, the abrasion of the crown cannot reach it so as to form an insulated fossette till the last stage of use, and ordinarily it is enwrapped by the very thick layer of cement, so as to be only indicated by a protuberant gibbosity, as is seen in m. 3 of fig. 2, Plate XVI., and less distinctly in m. 3 of fig. 1 of the same Plate. The channel, which is continued upwards from the cup, remains usually inconspicuous.

The last true molar, therefore, in the Gower species exhibits the remarkable combination of the following characters: namely, a triangular crown with a V-shaped summit, and two fossettes; one corresponding to the middle valley, the other to the posterior fissure; the posterior barrel narrow and compressed, and giving off a double crochet. In its systematic relations it occupies an intermediate position between *Rhin. bicornis* and *Rhin. tichorhinus.*

In the description of all the molars, reference has been made to the thick layer of cement. This dental constituent is present in greater or less quantity on the teeth of all the species of Rhinoceros. But in *Rhin. hemitœchus* the mass of the layer is so great as to become a character of specific importance. The proportion which it bears to the shell of enamel is best seen on the anterior barrel of m. 2 of fig. 1, Plate XVII. It is there partly denuded, and the enamel looks as if set in a casing of cement. In Fig. 2, Plate XVI., all the molars are completely enveloped by an enormous coat of cement, through which the edging of enamel protrudes. It is also most abundant in all the molars of Fig. 1, Plate XVI. In the last true molar of Fig. 2, Plate XVI., the cement is seen to form a thick layer, insinuated between the

plates of the double crochet and lining the walls of the valley. I have ascertained that it is equally abundant in all the molars of this species from the caves of Oreston and Durdham Down, and from the fluviatile deposits of Clacton, and other similar localities. In the teeth of existing species, such as *Rhin. bicornis* and *Rhin. simus*, the coat of cement cracks and dislaminates, by long exposure to the weather. This accident will account for its absence in certain teeth of *Rhin. hemitœchus*, in which the cement had probably disappeared from weathering before they were embedded in the matrix. When the matrix is a calcareous paste, the layer of cement is apt to be detached from the enamel along with it, as appears to have happened to the external surface of the molars in the Bacon Hole specimen, figs. 1 and 2, Plate XVII. The shell of enamel is very much thinner, in proportion to the other dental elements in this species, than in *Rhin. tichorhinus*. In the latter the external surface is very rugous, while in the former it is comparatively smooth. The difference is so considerable that in many instances the teeth of the two species can be distinguished by this character alone.

De Christol has directed attention to the fact, that in genera of the same families, the older forms have a less coating of cement on their teeth than the newer types. Thus, in *Hipparion*, the layer is much thinner in proportion than in species of the genus *Equus*, and in *Aceratherium* than in *Rhinoceros*. The same difference applies to the Miocene species of Rhinoceros as compared with the modern forms. He has ingeniously attempted to give a general expression to the observation, designating the older forms *Acementodontes*, and the newer *Cementodontes*. Without accepting the generalization as universally applicable, it is worthy of remark that cement abounds on the teeth of *Rhin. tichorhinus* and *Rhin. simus*, and in the extinct form *Rhin. hemitœchus*, while it is comparatively scanty in the teeth of *Rhin. megarhinus* and in specimens attributable to *Rhin. leptorhinus*.

Inferior Molars.—The molars of the lower jaw, in all the species of Rhinoceros, present fewer and less appreciable modifications of the general form than the upper; and they are in consequence of less avail in the distinction of the species. For this reason, they would have been described, on the present occasion, with much more briefness than the upper, but for the fact that the materials for instituting a comparison between *R. leptorhinus* and *R. hemitœchus* are much more abundant, in the shape of lower jaws and teeth, than of upper. Cuvier, having omitted to pay sufficient attention to the character of the upper molars in *R. leptorhinus*, during his journey

in Italy, left it as a behest to the naturalists of that country, to supply the deficiency. But nothing adequate to the demands of the subject has as yet been accomplished by them, and there is hardly extant a single good figure or description of an authentic upper molar of that form, to serve as a standard of comparison; while of lower jaws, besides the figures in the 'Ossemens Fossiles,' there exist in the Palæontological series of the British Museum several fragments containing teeth, from the Val d'Arno, furnishing the desired means in so far as the mandible is concerned.

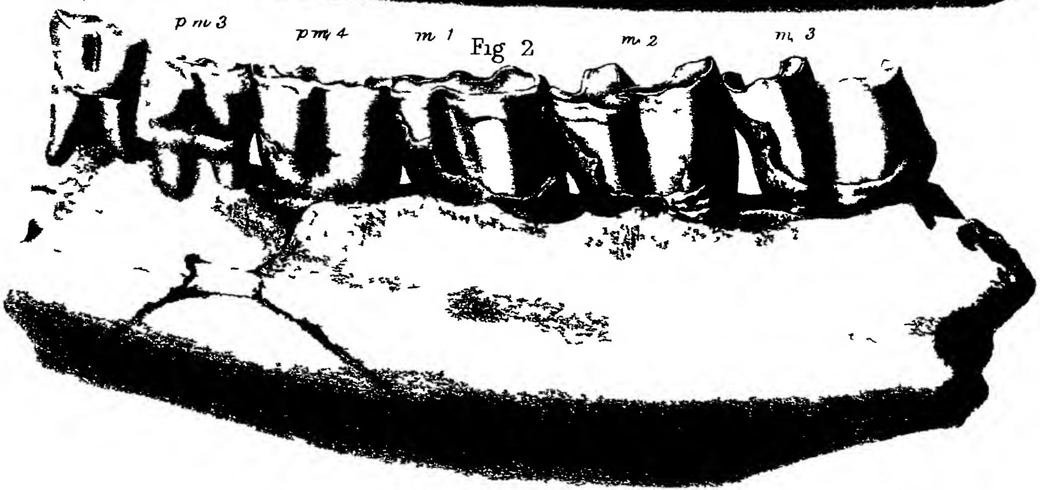
Figs. 1 and 2 of Pl. XIX. represent the greater portion of the horizontal ramus of the lower jaw, left side, of *R. hemitœchus*, containing the full series usually seen in the adult, of six molars. The crowns are in the stage of wear best suited to show all the characters, the last true molar, although abraded, having the divisions distinct. The specimen belongs to the Swansea Museum. Figs. 1 and 2 of Pl. XX. represent a fragment of a left ramus of equal extent, showing the five last molars *in situ*, and the empty alveolus of the antepenultimate premolar. The wear of the crowns had advanced so far in this specimen, that the four anterior teeth are ground down each to a uniform disc of ivory. Both specimens are from Minchin Hole, and belong to the collection of Colonel Wood.

Fig. 1 of Pl. XXI. represents a mutilated right ramus of the lower jaw, exhibiting also the six posterior molars *in situ*, together with a portion of the symphysial expansion. The specimen is remarkable, in showing the abnormal condition of two collateral teeth, for the last premolar. The crowns are seen in the early stage of abrasion of the adult animal. The specimen, discovered in 'Bacon Hole,' was presented to the Swansea Museum by Colonel Wood. Its dimensions are:—

Extreme length of 6 molars (very nearly), 10·0 in. Ditto of last three molars (to base), 5·97 in. Ditto of 3 anterior ditto, 4·0 in. Ditto of summit of crown last molar, inner side, from edge to edge of enamel, 1·8 in. Ditto of crown near base, 2·18 in. Ditto of penultimate crown, 1·95 in. Width of ditto behind, 1·25 in. Width of ditto in front, 1· in. Extreme width of last molar, 1·3 in. Extreme length of fragment, 12·5 in. Height of jaw inside, behind last molar, 4· in. Ditto in front of last premolar, 3·1 in. Length of summit of antepenultimate true molar (first), 1·7 in. Width of ditto behind, 1·2 in.

The first character that strikes the eye in the teeth of all the three specimens is the very thick layer of cement. In Pl. XX. the last true molar is completely encased in it; while the other teeth are more or less denuded, they show by the fractured edging that this has arisen from accident. The same appearance is presented by the molars of Pl. XIX., which are still more bared. The layer of cement, therefore,

Fig 2



J Dinkel del et lith

Rhinoceros hemitoechus

W West imp

Fig. 1.

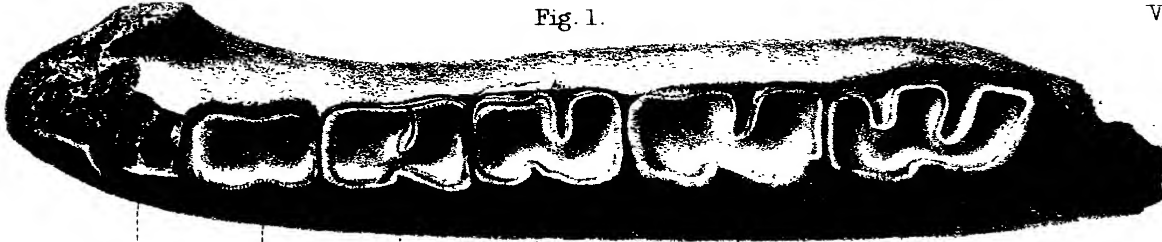
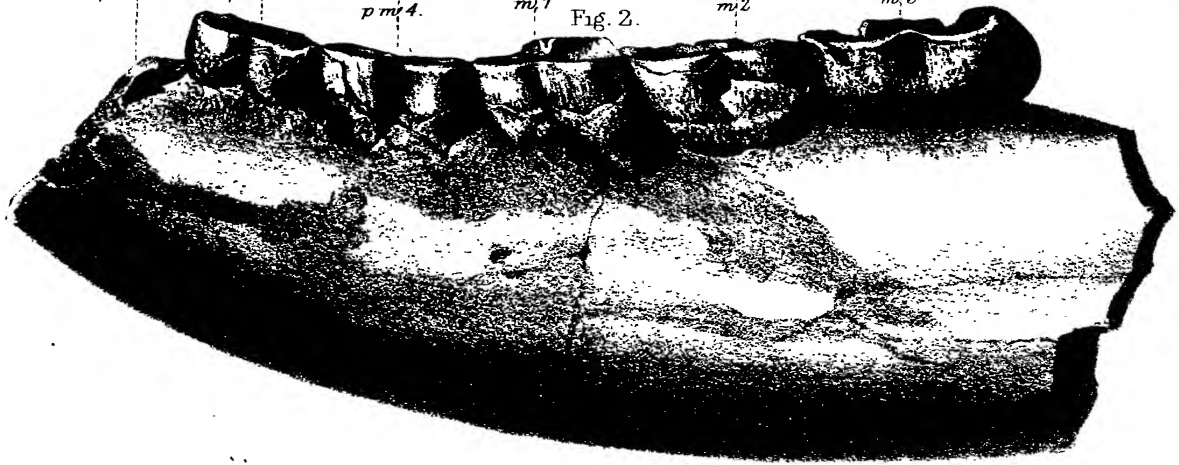


Fig. 2.



J. Dinkel del. et lith.

Rhinoceros hemitoechus

W West imp.

is present alike in the upper and lower molars in very great thickness.

Another character, equally obvious, is the very considerable amount of concavity in the common grinding surface of the teeth, in the antero-posterior direction, from the antepenultimate premolar to the last true molar. This concavity is much more pronounced than in the jaw of either *R. tichorhinus* or *R. megarhinus*, with which I have compared it; and that it is constant in *R. hemitœchus* is proved by its uniformity in the three jaws having teeth in different stages of wear.

Premolars.—The premolars agree very closely in form with those of *R. megarhinus*, the principal difference being in the proportion which their aggregate length bears to that of the true molars. The antepenultimate (p.m. 2 of Pl. XIX.), in horizontal section, is somewhat wedge-shaped, contracting from behind forwards to a narrow edge, which is bent inwards. Its outer surface shows the vertical groove of division between the two crescents, and on the inner side behind there is a well-marked niche indicating the concavity of the posterior crescent. In *R. megarhinus*, the antepenultimate in the same stage of wear is free from any corresponding indentation. The anterior edge in the Gower specimen forms a convex projection. The tooth agrees in the closest manner with the Clacton tooth figured in the 'British Fossil Mammalia,' Cut 136, p. 363, and there referred to *R. leptorhinus*. In the 'Bacon Hole' specimen (fig. 1, Pl. XXI.) the antepenultimate premolar repeats the form presented by p.m. 2 of Pl. XIX.

The penultimate (p.m. 3 of Pl. XIX.) has the crown ground down to a common sinuous disc. The indentation between the two crescents forms on the outer surface a deep niche directed forwards. The remains of the hollows of the crescents on the inner side show that they were deep and boldly defined. The crown of this tooth in *R. hemitœchus* is considerably smaller, both in the actual dimensions and relatively to the last premolar, than in *R. megarhinus* (*vide* Gervais, 'Paléontologie Française' (Pl. II. fig. 8).

The last premolar (p.m. 4 Pl. XIX.) presents an oblong crown, with two boldly pronounced crescents, which are nearly of equal size. It is also very much larger in all its proportions than the tooth which precedes it. Compared with the corresponding premolar of *R. megarhinus*, the following points of difference are observable:—

1st. That the crown is much longer in relation to the antepenultimate, and shorter in relation to the first true molar, than in *R. megarhinus*.

2nd. That the anterior horn of the front crescent is much

more developed and more nearly of the size of the posterior horn, in *R. hemitœchus* than in *R. megarhinus.*

As regards the first of these characters, the penultimate and last premolars in the latter species are nearly of equal size; while in *R. hemitœchus* there is a progressive increase in length of crown from the antepenultimate to the last. The difference is shown by the subjoined comparative measurements.

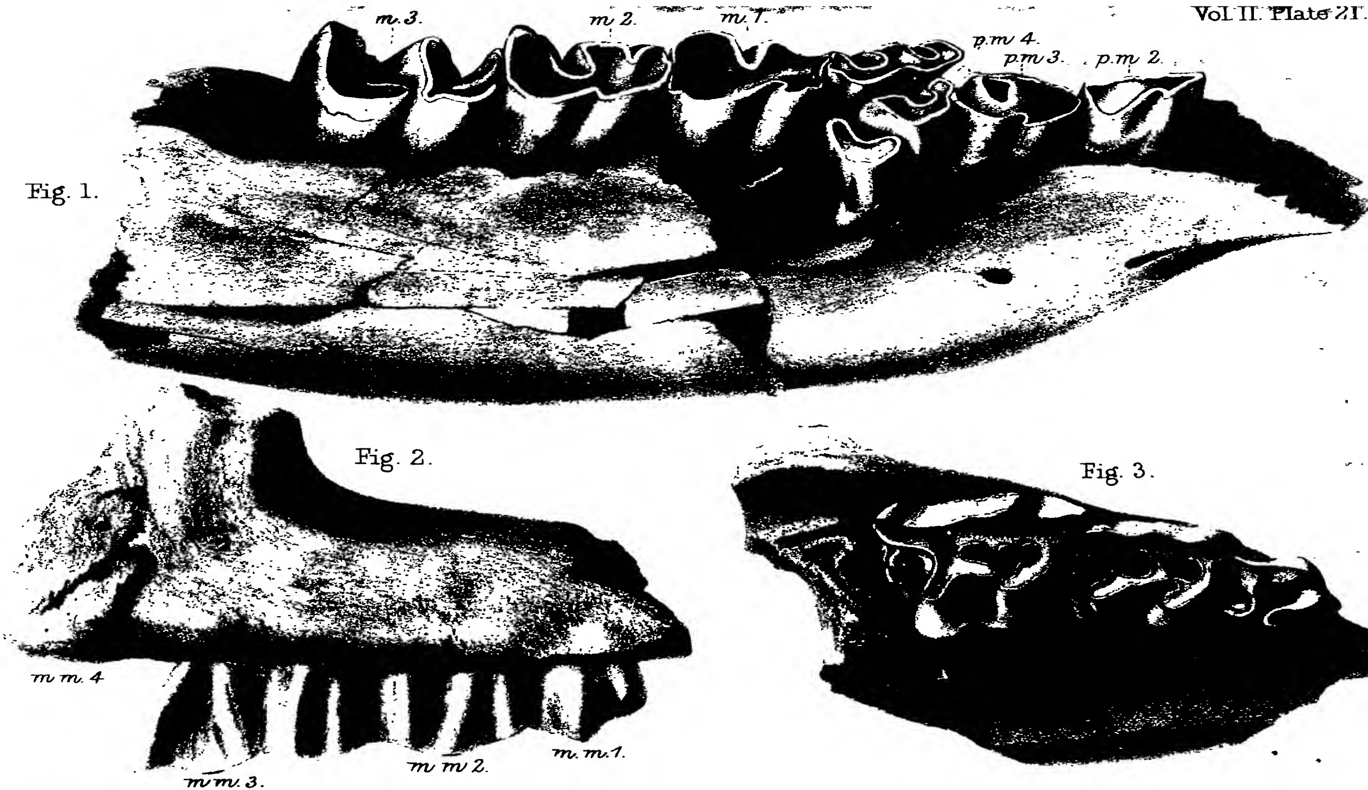
	Swansea lower jaw, R. hemitœchus	Owen's Clacton, Cut Br. Fos. Mam., p. 361	Gervais, R. megarhinus	No. 19,840 B. M.	Gunn's R. leptorhinus? (R. Etruscus. —Ed.)	Layton's lower jaw, R. Etruscus	Val d'Arno No, 28,802 B. M. Cat.
Length of 6 last molars .	10·	—	10·5	—	—	—	—
Length of space occupied by 5 last molars . .	8·8	8 8	9·3	8·5	8·15	—	—
Length of 4 last molars (1, 2, 3 m., and 4 p.m.) .	—	—	7·7	7·8	6·6	—	6·4
Length of 3 last molars .	6·	—	6·	—	5·3	—	5·1
Length of 2 last molars .	—	4·2	4·2	—	—	—	—
Joint length of 1st and 2nd true molars . . .	—	--	4·	—	3·4	3·3	—
Length of 3 premolars .	4·	–	4·5	—	—	—	—
Length of last true molar, over crown top . .	2 8	2·2	2·2	2·1	1·75	—	1·9
Length of ditto, base .	2 2	--	—	2 2	1·8	—	—
Width of ditto, behind .	1·3	1·4	—	1·3	1·1	--	—
Length of penultimate, do.	1 95	2·1	2·	2·1	1·85	1·8	—
Width of do., behind	1·25	1·6	—	1·3	1·15	—	—
Width of do., in front at base of crown . .	1·	–	—	—	1·2	—	—
Length of antepenultimate	1·7	--	—	1·9	1·5	—	—
Width of do., behind	1·2	—	—	—	1·15	—	—
Do. of do., in front	1·1	—	—	—	1·1	—	—
Length of last premolar	—	—	—	1·6	--	—	—
Do. of penultimate do.	--	—	—	1·4	—	—	—
Length of diastemo to incisive border . .	—	—	4·4	—	—	—	—
Height of jaw behind last molar, inside . .	4·	4·8	—	4·	3·9	—	—
Height of jaw in front of antepenultimate . .	3·5	—	—	—	3·35	—	—
Height of jaw to alveolar marg. at middle of inner side of p.m. 3 . .	—	3·5	—	—	—	—	—
Extreme thickness under last molar . . .	2·25	—	—	—	2·3	—	—

The second character is well exhibited, on comparing fig. 8 of Pl. II. of Gervais' 'Paléontologie' with Pl. XIX., annexed. In the former the anterior horn of the crescent, in p.m. 3 and 4, and in m. 2 and 3, forms an insignificant lobe, indicated by the anterior niche on the inner side of each of these teeth; while in p.m. 3 and 4, and in m. 2 and m. 3 of Pl. XIX. of *R. hemitœchus* the anterior horn of the crescent makes as large a sweep as the posterior horn. The

Fig. 1.

Fig. 2.

Fig. 3.



J. Dinkel del. et lith.

W. West imp.

Rhinoceros hemitoechus

common consent of palæontologists has pronounced against the value of distinctive characters, derived from the lower molars in the genus Rhinoceros; but the differences above indicated are so constant and well marked, that I regard them as being of specific importance.

In the 'Bacon Hole' specimen (fig. 1, Pl. XXI.), there are two points connected with the premolars deserving notice. In the penultimate (p.m. 3), the crown of which is well worn, a distinct fossette is seen. This is unusual, and has been caused in the present instance by the solution of a portion of the valley between the horns of the posterior crescent. The second point is that the last premolar is double, and represented by two collateral teeth, the outer of which is at a slightly lower level than the inner. The abrasion of the crowns of both these teeth, in relation to that of the penultimate premolar in front, and of the first true molar behind, proves that they are both of the second set, and not a permanent premolar protruded excentrically alongside of a retained milk molar.

True Molars.—The antepenultimate true molar (m. 1 of Pl. XIX.) shows the remains of two well-marked crescents, but being considerably worn it yields no distinctive characters. The crown is oblong, shorter than that of the penultimate. Compared with the corresponding tooth of *R. megarhinus* (Gervais, *op. cit.* Pl. II. fig. 8), it is narrower, in reference to the length. The penultimate (m. 2) being less worn shows the anterior crescent more pronounced; the posterior crescent takes a very oblique antero-posterior direction, its front lobe terminating near the outer third of the anterior crescent; and it represents but a small degree of curvature. The last true molar (m. 3) is the least worn of the three, the posterior crescent being distinct from and still at a lower level than the anterior crescent. Its anterior division presents a very pronounced horse-shoe pattern, with equal limbs. The posterior division is very oblique in direction, and its worn surface exhibits but a small amount of curve. The crown of this tooth is somewhat longer than that of the penultimate.

The dimensions of the same tooth in the same lower jaw vary not a little, according to the different stages of abrasion. They are all inclined a little forwards, and the length of a slightly abraded crown taken at the summit is less than that near the base. In consequence of difference in measurement, arising from causes like these, authors are not agreed in regard to the relative proportions of the different teeth, more especially the penultimate and last, which are the most significant. Duvernoy positively affirms that in *R. tichor-*

hinus the penultimate true molar is smaller than the last; while in *R. leptorhinus* the last is smaller than the penultimate; the latter species in his view been represented by the Rhinoceros jaws figured by Cuvier, from the Val d'Arno, and by the *R. megarhinus* of Montpellier. Brandt distinctly mentions, on two occasions, that in *R. tichorhinus* the last molar is a little larger than the penultimate. On the other hand, Professor Owen, in the table of comparative measurements between the teeth of *R. leptorhinus* and *R. tichorhinus*, given at p. 364 of the 'British Fossil Mammalia,' makes it appear that in *R. tichorhinus* the last true molar is smaller than the penultimate, the reverse holding with the teeth of the so-called *R. leptorhinus*, with which he compares them. But I entertain grave doubts whether the Cromer specimen, assumed in this instance as an example of *R. tichorhinus*, really belongs to that species. There are strong reasons to believe otherwise. An undoubted specimen of a lower jaw of *R. tichorhinus*,[1] from Lawford, is preserved in the Oxford Museum, in which the last true molar is slightly shorter than the penultimate. The dimensions of these teeth are given in the subjoined table of comparative measurements.

	Lawford	R. hemitœchus	Mr. Gunn's[2]
Length of crown of last molar, at apex .	1·7 in.	1·8 in.	1·75 in.
Length of crown of last molar, below . .	1·8 ,,	2·2 ,,	1·8 ,,
Length of penultimate, below . . .	1·85 in.	1·95 in.	1·85 in.
Length of antepenultimate, below . .	1·68 ,,	1·7 ,,	1·5 ,,

In *R. hemitœchus*, the teeth increase in length, uniformly, although not symmetrically, from the antepenultimate premolar to the last true molar, and the last true molar is ordinarily considerably longer than the penultimate. The relative proportions are best exhibited by the worn crowns of Pl. XX. In *R. megarhinus*, the ratio of the length of the three true molars to the three posterior premolars is as 6 to 4·5: and in *R. hemitœchus* as 6 to 4; the length of the whole series being nearly equal in the two species.

It now remains to compare the teeth of the Gower species with an important series of Rhinoceros remains, occurring in the 'Elephant-Bed' or 'Submarine Forest' of the Norfolk coast, near Happisburgh and Mundesley, which, so far as the evidence goes, constantly present well-marked differences. The most perfect of these consist of rami of the lower jaws with teeth. Upper molars are comparatively rare, and such of them as have been met with have in most instances been dispersed. No considerable fragment of a

[1] See p. 401.—[Ed.]

[2] *R. Etruscus.* See p. 345.—[Ed.]

cranium has yet been observed, nor an upper jaw containing many teeth. The most conclusive description of evidence to determine the species is, therefore, still incomplete. The best examples of these remains are to be seen in the collection of the Rev. James Layton, lately acquired for the British Museum, or that of Mr. R. Fitch of Norwich; and in the valuable collection of the Rev. John Gunn of Irstead.

Figs. 1 and 2 of Pl. XXII. represent a fragment comprising the greater part of the horizontal ramus of the left side of the lower jaw, with the three true molars *in situ*, and the empty alveoli of the three last premolars. The aggregate length of the series of teeth is less in this specimen than in either *Rhin. megarhinus* or *Rhin. hemitœchus*, and the proportions between the teeth are different; the relative length of the antepenultimate, penultimate, and last true molars being in *Rhin. hemitœchus* nearly as 1·7. 1·95, and 2·2, and in the Happisburgh specimen 1·5, 1·85, and 1·8. It belongs to the collection of the Rev. John Gunn at Irstead, and was found in the true Forest-bed, with roots of trees, &c., *in situ*.[1]

Another specimen from the collection of the Rev. James Layton, now in the Palæontological series of the British Museum, Cat. No. 33,326, is a corresponding fragment of the lower jaw left ramus, containing the last premolar, and the antepenultimate and penultimate true molars, together with the anterior fang of the last molar *in situ*. The ramus is mutilated in front through the anterior portior of the penultimate premolar, and behind through the last true molar. It is a trifle smaller in size than the previous specimen, and the teeth are a little more worn; but the form of the jaw and the relative proportions of the teeth correspond closely with those of the latter (Pl. XXII. fig. 3).

There are two fragments of lower jaws in the British Museum, presented by Mr. Pentland, from the Val d'Arno.[2] The one (No. 28,802 MSS. Palæont. Cat.) shows the upper or alveolar portion of the left ramus, containing the last

[1] Mr. Gunn has kindly forwarded to me this specimen, to be drawn by Mr. Dinkel. Affixed to it is a label in Dr. Falconer's handwriting, '*R. leptorhinus*, Cuv.' But as above stated (p. 314), Cuvier included under his *Rhin. leptorhinus* the Rhinoceros of the Val d'Arno, which Dr. Falconer subsequently separated and designated *Rhin. Etruscus*. The Rhinoceros of Messrs. Gunn and Layton's collections was therefore *Rhin. Etruscus*. See pp. 310 and 355.—[Ed.]

[2] Other specimens of the same species in Mr. Pentland's collection are also described in Dr. Falconer's note-books, viz.: No. 28,804, a last or penultimate true molar; No. 33,324, a last milk ? molar, upper jaw, right side; and No. 33,323, a last milk molar, upper jaw, left side. A tibia of Rhinoceros which accompanies these teeth is described as 'much more slender and considerably longer than that of the Clacton species.' The teeth are stated to have been from the Conglomerate *Sansino* of the Val d'Arno, and not from the *Sabbone* or blue clay.—[Ed.]

premolar and the three true molars *in situ*. The antepenultimate true molar is worn low, and the last tooth is well advanced in wear (Pl. XXII. fig. 4). In form, proportions, and size, the teeth agree very closely with those of Mr. Gunn's specimen. The second Val d'Arno specimen (No. 28,803 MSS. Palæont. Cat.) contains the penultimate and last true molars of the left ramus of the lower jaw. In form and size, they are exactly the counterpart of No. 28,802. The following are the comparative dimensions of the teeth in these specimens, contrasted with the same in *Rhin. hemitœchus*.

	Swansea lower jaw of Rh. hemitœchus	Owen's Clacton, Br. Fos. Mam. p. 361	No 19,840 of Brit. Museum collection	Gervais, Rh. megarhinus	Cast of Rh. megarhinus	Gunn's Rh leptorhinus (R. Etruscus.—Lb)	Layton Rh. leptorhinus (R. Etruscus.—Lb)	Pentlands' Val d'Arno, 28,802 of British Museum	Fitch's Cromer lower jaw, Owen, pp. 364 & 347	Rh. tichorhinus, Owen, Br. Fos. Mam., Cut 124
Length of the 6 last molars	10·	—	—	10·5	10·55	—	—	—	—	—
Do. of 5 last molars	8·8	8·8	8·5	9·3	9·3	8·15	—	—	—	—
Do. of 4 last molars	—	—	7·8	7·7	7·7	6·6	—	6·4	—	—
Do. of 3 last molars	6·	—	—	6·	5·15	5·3	—	5·1	—	—
Do. of 2 last molars	—	4·2	—	4·2	4·3	—	—	—	—	—
Do. of 1st and 2nd true molars	—	—	—	4·	4·	3·4	3·3	—	—	—
Do. of 3 posterior premolars	4·	—	—	4·5	4·5	—	—	—	—	—
Do. of last true molar	2·2	2·2	2·2	2·2	—	1·8	—	1·9	1·8	1·8
Width of do.	1·3	1·4	1·3	—	—	1·1	—	—	—	—
Length of penultimate do.	1·95	2·1	2·1	2·	—	1·85	1·8	—	1·9	1·85
Width of do.	1·25	1·6	1·3	—	—	1·15	—	—	—	—
Length of antepenultimate do.	1·7	—	1·9	1·9	—	1·5	—	—	—	1·68
Length of last premolar	—	—	—	—	—	1·6	—	—	—	—

The agreement of the Happisburgh and Tuscan teeth so closely, in size, form, and proportions, excites attention to

Fig 1

Fig 2

Fig 3

Fig 4

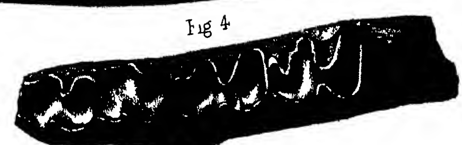


Fig 5

W West. imp.

Rhinoceros Etruscus
(1, 2, 3, 5, Norfolk. 4 Val d'Arno)

J Dinkel del. et lith.

their other dental characters. Cuvier, in describing the lower jaws of his species 'à narines non-cloisonées' of Italy, refers to figs. 8 and 9 of Pl. IX., representing Tuscan specimens, in proof that it had seven molars below in the adult state, the pre-antepenultimate or first premolar, which is suppressed in the Siberian Rhinoceros, being developed; and he seized upon this character as a distinctive mark of his *Rhin. leptorhinus.* This pre-antepenultimate, although present in the milk dentition, is suppressed in *Rhin. hemitœchus* in the adult state, and it is also wanting in *Rhin. megarhinus.* Thence, it becomes a point of the highest interest to ascertain, whether it was present or suppressed in the fossil Rhinoceros of the 'Elephant-Bed' of Happisburgh. Professor Owen has described (Brit. Fos. Mam., p. 347) a fine specimen, comprising the greater portion of the horizontal ramus of the lower jaw of a Rhinoceros, procured from the 'Lignite Bed' of Cromer, being an extension of the Happisburgh deposit. In this fragment, which is of a young adult, there were four premolars and three true molars. Of the latter, two are in place, and the last emerging; of the former, the alveoli of the first remain, the two next are in place, and the fourth or last is embedded in the jaw under the last milk molar, which had not yet been shed. A portion of the wall of the jaw has been excised, and the milk tooth is seen superimposed to its successor. The pre-antepenultimate premolar in this case had dropt out, but the fang-pits prove beyond question that it had been there. Professor Owen has selected this specimen as a standard example of *Rhin. tichorhinus*, for comparison with a corresponding jaw of his *Rhin. leptorhinus*, and he has given measurements of the two in contrast. I have seen the specimen in question, in Mr. R. Fitch's collection in Norwich, and both the form of the jaw and the relative proportions of the teeth conveyed to my mind the impression that it belonged neither to *Rhin. tichorhinus* nor to *Rhin. hemitœchus*, but to the same species as the specimens above described, of Messrs. Gunn and Layton, *i.e.* to the 'Rhinoceros à narines non-cloisonées' of Cuvier, from Tuscany. Not having the fragment now before me, I am desirous of expressing this opinion with diffidence and reserve.

Professor Owen was probably influenced, in arriving at the above identification, by the belief that he had established the fact that the first premolar is present in the lower jaw of *Rhin. tichorhinus*, although Cuvier had asserted the contrary. In the 'British Fossil Mammalia' he has given a representation, natural size (fig. 137, p. 363), of the two anterior teeth of a young fossil jaw from Lawford, preserved in the Oxford Museum. These teeth he considers to be pre-

molars, and he contrasts the second with an antepenultimate premolar (fig. 136, *op. cit.*), also natural size, of the Clacton species. The difference both in size and form between the two is assuredly very great, and if the comparison were well founded and sound, it would furnish a strongly marked distinctive character of the species; but it appears to me, that in this case this eminent palæontologist has fallen into the error of comparing the milk tooth of one jaw with the corresponding permanent premolar of another. The Clacton tooth is unquestionably a permanent premolar of the second set; but the Lawford jaw (figs. 128 and 137, *op. cit.*) contains four teeth, presenting as it seems to me the characters of milk molars. Without going, on the present occasion, into the details of the evidence for this conclusion, I may state that I have compared the figure of the pre-antepenultimate (p. 1 of Cut 137, above referred to) with the pre-antepenultimate milk molar of a very young jaw of *Rhin. hemitœchus*, in Col. Wood's collection from 'Minchin Hole,' and found them agree in size and form, to the most minute particulars. Brandt, with access to the rich collections in the Russian Museums, distinctly states, in his monograph on the Siberian Rhinoceros, that he had never seen an adult lower jaw of this species showing more than six molars, thus confirming the early inference of Cuvier. The definite settlement of this point, when well ascertained, will be of much greater importance than merely determining the precise number of inferior molars in an extinct species. Hence the reference to it now. The presence of seven lower molars in the lower jaw from Cromer furnishes of itself, independently of the other evidence, strong grounds, to my mind, in favour of the specimen being referable to the 'Rhinoceros à narines non-cloisonées,' and not to *Rhin. tichorhinus*. It will be a remarkable fact in Geology if it is proved that the latter species was a contemporary of the Sub-Apennine *Elephas meridionalis*, as well as of the Glacial Mammoth.[1]

[1] The above was written in 1860 The Rhinoceros of the Val d'Arno and of the 'Submarine Forest-bed of the Norfolk Coast' was subsequently designated by Dr Falconer *Rhin. Etruscus*. See pp 310 and 355.—[Ed.]

APPENDIX TO MEMOIR ON RHINOCEROS HEMITŒCHUS.

Extracts from Dr. Falconer's Note-books.

I.—NOTE ON LOWER JAW, RIGHT SIDE, OF RHINOCEROS HEMITŒCHUS, FROM BACON'S HOLE, IN SWANSEA MUSEUM. (See p. 340.)

27th April, 1858.

Compared the original of Spence Bate's drawing (Plate XXI. fig. 1) with Mr. Gunn's specimen from the Norfolk coast. They are very different. Spence Bate's drawing is not in exact profile. In the original, the collateral last premolars attain nearly the same height, and are worn exactly as a single tooth, the outer one a little lower. They are not *milk* and true premolars, but *double* premolars of the second set. The contour is not well shown in the drawing, particularly of the anterior end, the jaw not having been placed vertically, but sloped outwards, to show the crowns. The enamel of the teeth is smooth. There are two very large mentary foramina, the one under the front of antepenultimate premolar, the other under the back of penultimate. The front one round and very large.

The most remarkable difference is in the contour line of the lower jaw, which is curved in the arc of a circle very much as in the African two-horned rhinoceros; whereas, Gunn's specimen (Pl. XXII. fig. 1) is nearly wedge-shaped, without any considerable curvature. It is certainly not *R. leptorhinus*. Gunn's specimen is also thicker; the inner longitudinal channel more marked, and the posterior one also; the teeth are shorter and thicker in Gunn's (relatively). The antepenultimate true molar in Mr. Gunn's specimen is also very much thicker in proportion to the length.

	Gunn's	Swansea
Extreme length of fragment at base	11·4	12·5
Length of three last teeth	5 3	6·0
Length of last worn crown	1 75	1 8
Ditto near base	1·8	2·18
Width of ditto behind	1·13	1·3
Length of penultimate	1·8	1·95
Width of ditto, behind	1·15	1·25
Ditto, front, base of crown	1·2	1·
Length of antepenultimate	1·55	1·7
Width of ditto behind	1·15	1 2
Width of ditto in front	1·1	1·08
Height of jaw behind last tooth, inside	3·9	4·
Ditto in front of antepenultimate	3·35	3·5
Extreme thickness under last tooth	2·3	2 25
Length of space occupied by five last teeth	8·15	8·8

II.—NOTE ON MOLARS OF RHINOCEROS HEMITŒCHUS, FROM DURDHAM DOWN, IN BRISTOL MUSEUM.

4th May, 1858.

But the most interesting of all are a set of upper molar teeth of Rhinoceros, identical with the Rhinoceros of Bacon Hole! Of these, four belong to the left side and fit in pairs, of which two are worn

premolars, and the two others the antepenultimate and penultimate true molars.

The antepenultimate true molar is worn very low down, and the anterior barrel is broken across diagonally from the outer anterior angle inwards, so that it cannot be fitted to the premolar preceding it. The posterior notched valley is ground down into an isolated pit, with a shelving inner wall (not vertical, as in *Rhin. tichorhinus*). The transverse valley terminates in a very round sweep, without any combing processes thrown into it. The enamel edge is thin, and the surface of enamel very smooth, with an enormous coat of cement.

The penultimate agrees exactly in measurement with the Swansea tooth, but it is more worn. The posterior valley is spacious and angular, and not yet isolated; the transverse valley is divided into two divisions by a bold projecting curved crochet, given off from the posterior barrel; the posterior division of the valley is roundish lengthwise, but no combing processes; has a distinct basal tubercle.

The coat of cement is enormous, and very much like that of the Swansea specimen.

The two other teeth which fit are also of the left side; and probably the penultimate premolar and antepenultimate, both well worn. The posterior tooth has the posterior valley reduced to an oval fossette, isolated. The transverse valley is also isolated, with three comb-shaped processes from the posterior barrel, but *none* from the outer wall.

Dimensions.—Length, along outer edge, 1·7 in. Length of inner ditto, 1·5 in. Width in front, 2·05 in.; width behind, 1·65 in., approximative.

These agree very closely with the Swansea measurements.

The antepenultimate premolar is still more worn; the posterior fossette smaller, less oblong (rounder), and more isolated; the transverse valley has three processes thrown into it from the posterior barrel, but none on the outer side. The tooth has distinctly two barrels, and is too large for the antepenultimate.

Dimensions.—Length, outer side, 1·5 in. Length, inner side, 1·35 in. Width of crown in front, 1·9 in. Width of crown behind, 1·6 in.

III.—Memorandum of Skull of Rhinoceros Hemitœchus, in the Collection of Major Wood; from Minchin Hole. (See p. 323.)

The specimen is a superb fragment, comprising the whole of the cerebral part of the skull, but vertically broken through about two inches in front of the posterior termination of the temporal fossa. It is clear from the recent condition of the fracture that the facial part of the skull was broken and destroyed during extrication. The following parts are present. The sphenoidal region quite entire, also the two condyles with the foramen, and nearly the whole of the occiput up to the niche of the occipital crest; the lateral margins quite entire The two auditory foramina quite entire, also the left mastoid, but the styloidal process on both sides broken off. The zygomatic arches both broken, but the base present on the left side; and on both sides, but more especially on the right, the greater part of the articulating surface for the lower jaw is present, broad, and somewhat of a cordate pattern, with the sinus directed backwards. (See Plates XXIII. and XXIV.)

IV.—Comparison of the Gower Cave Rhinoceros, with Specimens in British Museum.

30th September, 1858.

Spent a long day with Mr. Waterhouse upon the Fossil Rhinoceros. Took with me all Major Wood's specimens from Minchin Hole and the Swansea Museum—specimens of upper and lower jaw, and the Minchin skull. Compared the Minchin skull with the two crania, the Clacton one figured by Owen and the other from Northampton, and found them to agree exactly in the form of the occiput, little amount of backward extension and vaulting of occipital crest, and in the form of the occipital plane, *i.e.* contracting upwards, and not a parallelogram, as in *Rh. tichorhinus*. Thus inferred that the *Rh. leptorhinus* of Owen's cranial figures is the same as our *Rh. priscus*[1] (*R. hemitœchus*) of the Gower Caves. (See Plates XXIII. and XXIV.)

V.—Note on the Northampton and Clacton Skulls of Rhinoceros Hemitœchus.

1st October, 1858.

The Northampton Rhinoceros skull in the British Museum, No. 2, *R. leptorhinus*, Owen, and labelled 20,013, is entered in the book as having been purchased in 1816 from Miss Baker of Northampton, sister of Baker the historian. The exact locality is not mentioned, but other specimens of the same lot are referred to Blisworth, Kilsby Tunnel, Bugbrook, Northampton, &c., all in Northamptonshire. This specimen comprises the occiput and condyles, quite entire, and the whole of the frontal on to the naso-frontal suture, which is also quite entire, as are also the base of the right zygoma, the right articulating surface, and the right styliform process; the left zygoma is less perfect. The animal was very young, although large as compared with that from Minchin. There is no evidence as to the age of Brown's Clacton skull (B. M. 132, 133); there is no sign of any of the sutures being open; but the upper part of the occiput is not broader than in the young Northampton specimen. Of the three molars which Brown gave with the skull, the last molar is implanted in the maxillary, with part of the palatine bone present. The tooth is of the left side, and is in the middle stage of wear, and is precisely like the pair of Minchin molars. If this fragment belongs to the skull it would prove the animal to have been adult. The antero-post. length inside of the tooth is 2·15 in. in Clacton, and 2·1 in. in Minchin. Like the Minchin specimen, the Clacton last molar has a basal lobe behind and an intercolumnar tubercle, but both are wrapt up in an enormous mass of cement. The complexity of pattern is equally great in both. In the Clacton skull there is no distinct mark of a frontal horn. The base is not quite smooth, but it is not rugous enough. The frontal of the Northampton skull is absolutely smooth, but the animal was young. (See Plates XV., XXIII., and XXIV.)

Dimensions of Clacton Skull.—Length from tip of nasals to summit of occipital crest, measured along the curve, about 29· in. Length from tip of nasals to summit of occipital crest, stretched, 28·5 in. Width of inter-temporal plateau of sinciput where narrow, 1·4 in. Length of nasal sinus (septum), 9·5 in. Length of nasal sinus (septum) in skull of *R. tichorhinus*, 7· in. Length of base of partial septum, about 5·0 in. Length of unossified part, about 4·in. Width of nasals in a line across with base of sinus, 5·8 in. Width of nasals at commencement of septum (posterior end), 4·7 in. Length from anterior side of styliform to nasal sinus, 13·0 in.

[1] *Rh. priscus* was the name first given by Dr. Falconer to *R. hemitœchus*.—[Ed.]

Comparison of Minchin Skull with young Northampton Skull.

	Minchin Skull	Young Northampton
Across the condyles, outer angles	6·	5·3
Length, lower surface, left condyle	2·65	
Depth from lower edge, right condyle, to occipital crest, right side	8·5	7·8
Width of occipital plane near apex	6·	
Width behind orbitary (auditory?) foramen, and a little above	9·3	8·4

VI.—Note on Young Lower Jaws of Rhinoceros Hemitœchus.

College of Surgeons, 15th October, 1858.

Examined a very beautiful young lower jaw, left ramus; the greater part of symphysis present with whole of horizontal ramus; the posterior angle wanting, but a part of the ascending ramus present; what there is of it reclines, but of the posterior lower part the whole is restored in plaster. What remains of the ramus agrees with the next specimen. It is from Minchin Hole, and has two foramina near symphysis, like the other specimens. It contains the deciduous dentition quite perfect, and all emerged, namely, 1st, 2nd, 3rd, and 4th milk molars; all more or less worn, except the first, which is perfectly entire. In form it resembles exceedingly the figure in Owen's 'British Fossil Mammalia,' Cuts 128 and 137 of the young jaw, from Lawford, confirming the impression that the latter is also a milk specimen. Strange to say, the first tooth is unworn. (See Pl. XXV. fig. 1.)

Dimensions.—Length of the four m.m. 5·2 in.; of 1 m.m., 0·8 in.; of 2 m.m., 1·1 in.; of 3 m.m., 1·6 in.; of 4 m.m., 1·7 in.

Another specimen, also from Minchin Hole, is the right ramus of the same animal. It is less perfect, and contains the 2nd, 3rd, and 4th milk molars, and the alveolus of a 1st,—a single pit of perhaps two confluent fangs. The symphysis has been partly restored, and does not fit to the left ramus.

Further, compared the first milk molar of the left jaw with Owen's figure (Cut 137, p. 363); the latter is of the inside apparently; they agree to the minutest particulars. Can the real Rugby specimen really be of *Rhin. priscus?* (*R. hemitœchus.* See *antea*, p. 348.)

Compared the third specimen of lower jaw from Minchin; a little older. It is superb; comprising the whole of the horizontal ramus and symphysis, with the ascending ramus and the greater part of the condyle; surface eroded, and the coronoid broken off obliquely down in a line with sigmoid notch; the ascending ramus reclines exactly as in *R. tichorhinus*, but the contour of the lower jaw is decidedly different. There is no abrupt step of ascent, as *R. tichorhinus.* There is more convexity below, but the curve is gradual in front, as in *R. bicornis*, the ramus of which also reclines much.

VII.—Notes on Milk Dentition of R. Hemitœchus.

College of Surgeons, August 6, 1859.

Examined two milk molars (second and third), fitting together, of *R. hemitœchus*, from Colonel Wood (Minchin Hole). They are very fine, though well worn. There is also a detached shell in germ of the second milk molar, right side, quite intact, and with the enamel only

Fig 1

Fig 2

J Dinkel del et lith

Rhinoceros hemitoechus
1 Minchin Hole 2 Northampton

W West imp

Vol II Plate 24

Fig 1

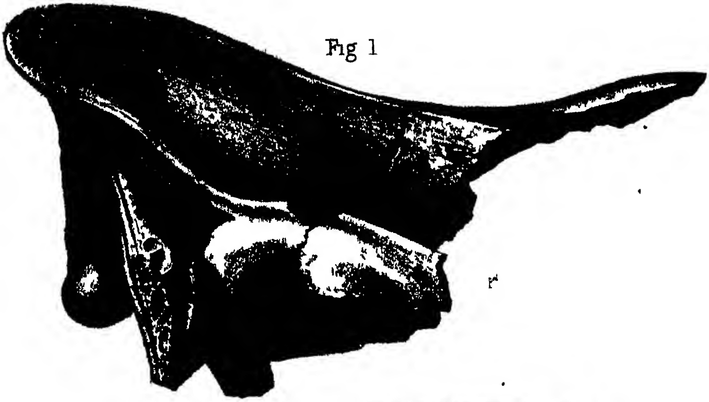


Fig 2

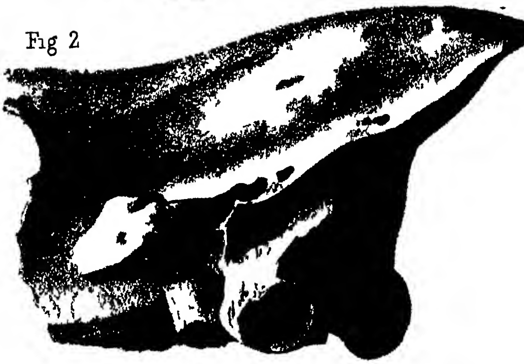
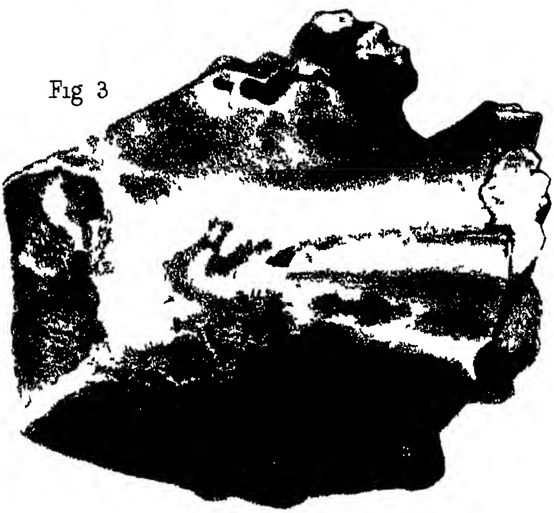


Fig 3



Dinkel del. et lith.

Rhinoceros hemitoechus
1 Northampton 2,3 Minchin Hole

ossified. A third milk molar in wear is very like Cesell's tooth from Rome. (See Pl. XXV. figs. 2, 3, and 4.)

Examined also a right maxillary with milk dentition. (See Pl. XXI. figs. 2 and 3.) The first, second, and third deciduous teeth are beautifully seen in place. The teeth are worn, and part of the alveolus of the fourth milk tooth is also seen. The second tooth has three fossettes besides the entrance of the valley. The specimen is exquisitely fine. There is no matrix on it, but it is probably from Minchin Hole.

Length of three teeth, 3·8 in. Length of 3rd milk molar, outer side, 1·7 in. Greatest width of ditto in front, at base, 1·6 in. Length of 2nd milk molar, 1·4 in. Length of 1st milk molar, 0·9 in.

[References to other bones of the skeleton of the *Rhinoceros hemitœchus* from the Gower Caves are to be found in Dr. Falconer's Note-books. The femur was compared with the femur of *Rhinoceros tichorhinus* of Mr. Lucas from Port Inon, referred to by Dr. Buckland. It was found to differ remarkably 'in its much shorter proportions, and in the very bold curve intercepted between the third trochanter and the outer condyle. The bone itself is absolutely much shorter and smaller, and the species must have stood on proportionally shorter legs.' The following reference to a tibia is also important:—'The bone is short and squat, as compared with the corresponding bone of *Rhinoceros tichorhinus*, and the fibula is ossified with the tibia along a much greater extent of surface. This specimen is of great importance in giving the characters of the species' The bones of the cranium are also referred to in the author's essay on 'the Ossiferous Caves of Gower.' In a list of Rhinoceros remains from Bacon Hole, in the Swansea Museum, mention is made of the lower half of right humerus, upper half of radius with articulating surface of ulna, pelvis, cervical and dorsal vertebræ, a thick and short metatarsal bone, &c.—Ed.]

VIII.—Note on Rhinoceros Hemitœchus from Folkestone.

27th September, 1858.

In Mr. Mackie's collection of fossils from excavations made at Folkestone there is a specimen (labelled 'Battery') of the last upper molar, left side, of *R. hemitœchus*. The shell is nearly entire, but the fangs are wanting. The grinding surface is a little damaged by minute chips, but there is no sign of wear. The crown, however, is very perfect, and presents the characters of the species well marked—namely, the last barrel compressed, and emitting from the middle forwards a large crochet plate. The valleys have a thick coat of cement, but the outside is denuded. This is an important specimen, and ought to be figured. It entirely agrees with Colonel Wood's specimens from Bacon Hole Cave.

IX.—Note on Rhinoceros Hemitœchus from Oreston.

College of Surgeons, 10*th August*, 1859.

To-day compared the Rhinoceros teeth from Oreston, described by Whidbey in the 'Phil. Trans.' for 1817, -21, and -23, and referred to by Owen in Brit. Fos. Mam. as belonging to *R. tichorhinus*. There are only three upper molars, Nos. 877, 878, and 879. The first is the right upper antepenultimate, and the second the left do. of probably the

same individual. Both are broken, but conversely, *i.e.* the anterior end of 877 and the posterior of 878, so that jointly they give the complete form of one tooth. They agree in both showing the crochet of the posterior barrel stretching across to join the anterior barrel, as in Cuvier's drawing.[1] They are quite unlike *R. tichorhinus*, and I believe that they agree with *R. hemitœchus*.

X.—Note on Rhinoceros Hemitœchus from Crawley Rocks.

Oxford, 11th August, 1863.

The Crawley Rocks Rhinoceros tooth in the Oxford Museum is a very fine penultimate or last premolar of *R. hemitœchus*, upper jaw, right side, with crochet in two combing plates. Length of crown outside, 1 74 in.; do., inner side, 1·25 in. The tooth is beautifully marked, and ought to be figured. The valley is very deep. In the Kirkdale series, besides the large worn molar there are two premolars, both germs, the one exactly corresponding in size and form with the Crawley Rock premolar, but intact, and has only one developed combing plate; the second is also an intact germ of the antepenultimate premolar, left side, of the same species; the entrance of the valley here also being vertical. Both these specimens profess to be from Kirkdale, but they differ in mineral appearance from the other. They bear no label, and they agree in condition exactly with the Crawley Rocks specimen. Can there be a mistake? Are they from Gower?

Oxford Museum, 5th July, 1860.

Saw one premolar of *Rhinoceros hemitœchus*, well marked, in a drawer, and labelled 'Crawley Rocks.'

II. NOTES ON RHINOCEROS ETRUSCUS. (Falc.)

(*Extracted from Dr. Falconer's Note-books.*)

I.—Note on Rhinoceros Etruscus in Oxford Museum.[2]

6th May, 1858.

In Buckland's collection there is a left upper maxillary and half palate of a Rhinoceros labelled '*Rhinoceros leptorhinus* from Venice,' in a hard ferruginous matrix of gritty sandstone. It contains four molars *in situ*, namely, p.m. 3 and 4, and t.m. 1 and 2, and also the broken-off discs of p.m. 2 and t.m. 3. The two premolars are of the second set and half worn. The first true molar is much worn; the penultimate is half worn. The enamel is very smooth, and the teeth are smaller than in the Kirkdale specimen. There is a considerable basal bourrelet at the anterior end of the last premolar and of the penultimate true molar. There are no combing processes whatever projecting into the transverse valley, and no appearance of cement. It reminds me of Ansted's specimens from Malaga. (See p. 360.) The outer surface of the two true molars from the termination of the valley is gone, but it shows the transverse valley well. The first true molar has its anterior outer corner broken, and the third and fourth p.m. have their

[1] See *antea*, p. 337.—[Ed.] [2] See p. 348, *note*.—[Ed.]

Fig. 1.

Fig. 2.

Fig. 3.

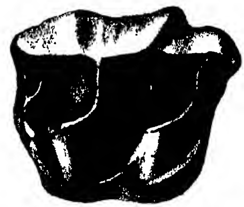


Fig. 4.

Fig. 5.

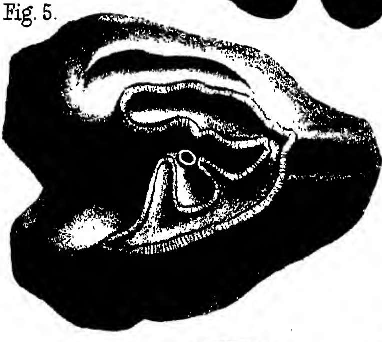


Fig. 7.

Fig. 6.

J. Dinkel del. et. lith.

1, 2, 3, 4. Rhinoceros hemitoechus, Gower Caves.
5, 6, 7. Rhinoceros Etruscus from Pisa.

W. West imp.

outer surface as to the valley broken off. There is a little mammilla between the barrels of the first and second true molars. In the third and fourth p.m. the end of the valley is only a very slight cleft; in the true molars it is an open flexuous fissure.

Dimensions.—Length of 5 teeth (2nd p.m. to end of 2nd t.m.), 7·5 in. Length of 2nd t.m. at middle, 1·85 in. Width in front, 2·2 in.

Can this really be from the Sub-Apennines?

II.—Comparison of Rhinoceros of Norwich Lacustrines with 'Venice' Upper Jaw in Oxford Museum.

7th May, 1858.

Compared the Rev. Mr. Gunn's detached upper molar (Pl. XXII. fig. 5) from the Norwich lacustrines with the upper jaw labelled '*Rh. leptorhinus* from Venice' in Buckland's collection, and found the most important agreement. Gunn's also belongs to the left side. In form Gunn's would agree best with the last premolar from the smaller size of the posterior barrel, but unluckily the fracture of the outer surface of the Venice fossil prevents a rigid comparison. They agree in the following important points:—1. Exact similarity of smooth enamel surface. 2. Decided anterior basal bourrelet, worn down in Gunn's. 3. Like thinness of enamel. 4. Sweep antero-posteriorly of termination of large valley, and its nearly isolated form. 5. Openness of gorge of transverse valley.

Dimensions.

	Gunn's specimen	Venice second true molar
Length of outer side at constriction		1·8
Length of inner side		1·6
Breadth near middle, anterior barrel		about 2 2
Breadth behind, at base of crown		2·2
		First true molar
Length of outer side (greatest)	2·0	1·75
Length at constriction	1·75	1·6
Length of inner side	1·85	1·7
Breadth of middle, anterior barrel	2·2	2·2 nearly
Breadth behind at base	1·9	2·15
Height of enamel crown, posteriorly	1·2	1·

Norwich, July, 1863.

Examined the Rhinoceros jaw in Fitch's collection. It belongs to *R. Etruscus*. M. Lartet detected in it the remains of the large mentary foramina. 'Got at Anderson's the fisherman's a portion without ends of a femur of an old *R. Etruscus*, very characteristic.'

III.—Description of Crania of R. Etruscus in the Grand Ducal Museum at Florence (Plates XXVI. and XXVII.).

18th May, 1859.

In the Museum at Florence is preserved a superb skull of *Rhinocéros Etruscus* from the Val d'Arno, nearly entire; two-horned, and very old. There are six molars on either side, of which even the last is worn to the base. The skull is very little crushed, and there are very few restorations. The nasals are perfect to their very tips on one side,

and are slightly emarginate and arched at the side, very much as in *R. tichorhinus*. They send down a vertical bony partition, which is deepest in front; the posterior part is broken, but does not appear to have been ever complete behind (only partial); what remains occupies one half of the nasal echancrure. The incisive bones are broken off, but on the right side a considerable portion of the diastema remains. The arch of the nasals is higher than in *R. tichorhinus*; and the greatest height of the septum is in front—the septum being lower behind, which is the very reverse of what is observed in *R. tichorhinus*. The broken part of the incisives has been badly restored in coloured gypsum, but the join is easily recognizable. Compared with the Lyons skull of *R megarhinus* (Plate XXXI. fig. 3), the Florence head is considerably smaller in all its dimensions, and the lower jaw and teeth are in keeping. Viewed from the top, the skull in contour resembles more that of the *R. tichorhinus* (Cuv., 'Oss. Foss.,' Pl. 160, fig. 5, and Gervais of the Montpellier skull, 'Trans. Academ. Montp.' tom. xi. Pl E. fig 2) than any of the others. Length from about outer margin to occipital crest, 14 in., and from ditto to tip of nasals about 12·5 in., or as 7 : 6.

The nasal horn rugosity is enormous, projecting greatly at its central nucleus; then there is a smooth interval of about three inches, and then an indistinct and not much raised rugosity for a second horn. This frontal horn was probably small; and there is here nothing like the enormous confluent rugosity of *R. tichorhinus*. The right orbit with rim is nearly entire, but the tubercles are broken off; they are smoothly restored on left side. The maxillary bone on right side is a little crushed below the infra-orbitary foramen. The zygomatic arches are quite entire, thin and high, and but little crushed. The articular surfaces are also entire on both sides. There is only a slight rise for the frontal horn between the orbits. The frontal and sincipital surfaces are smooth, with a tablet showing about the same width as in Gervais, Tab. 11, fig. 2; the two bounding ridges are visible but indistinct. (There is some restoration between the temporal arches on both sides.) There is hardly any sincipital pyramid, but the occiput is slightly crushed on the left side. The occipital plane rises nearly vertically, but is overarched at the sides by the projecting occipito-parietal crest, and an easy echancrure in the middle. This part of the skull is formed very much after Gervais' figure above quoted. The occipital plane is wide, and very low as compared with width. (Some little plaster restoration on right side.)

Florence, 19th May, 1859.

The skull of *Rhinoceros Etruscus* in the Florence Museum has the following characters (see Plates XXVI. and XXVII.):—[*]

1. It is smaller and more slender than the horned rhinoceros of Sumatra (Cuv. Pl. IX. *Rhin.*).

2. The cerebral portion is very elongated and shelving behind over a vertical occiput; it is but little elevated behind.

3. The skull is very flat from the occipital crest forwards; there is no pyramid properly so called (*vide* 'Dimensions').

4. The posterior surface of the occiput (when the skull is placed upon the plane of the teeth) is inclined forwards, and is overarched by the shelving occipital crest (Plate XXVI. fig. 1).

5. The nasal bones are more elongated than in the Cape species;

Fig 1

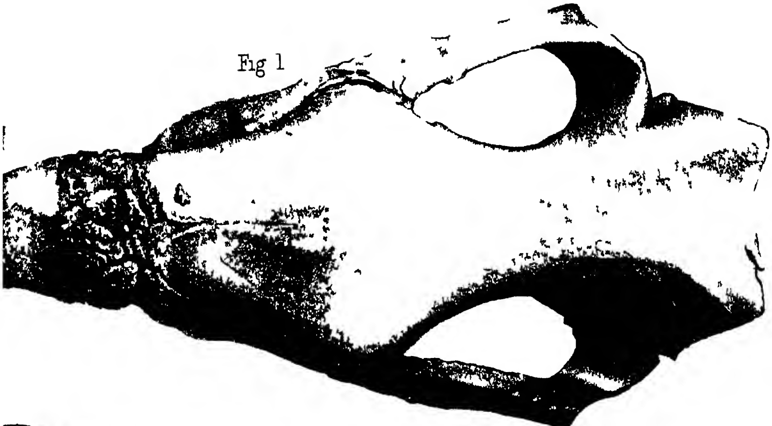


Fig 2

Fig 3

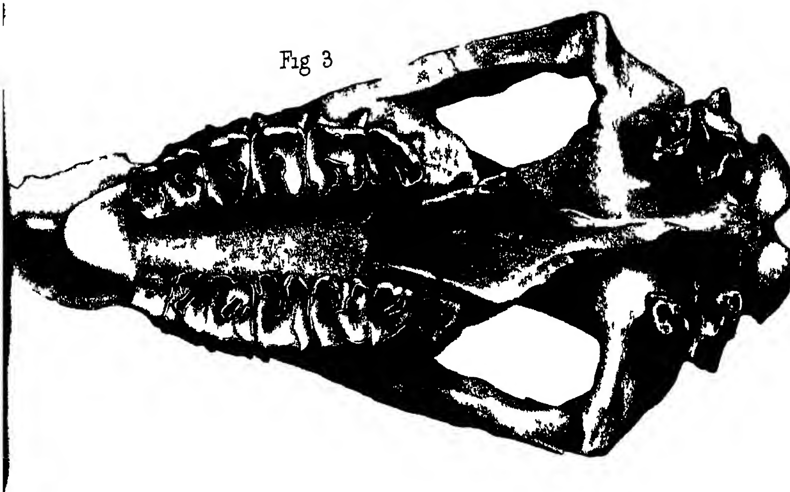


Fig. 1.

Fig. 5.

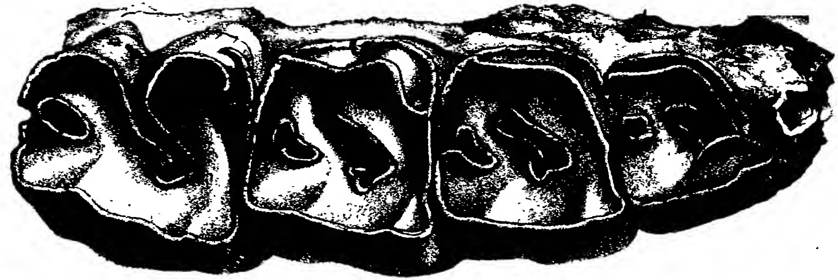


Fig 2

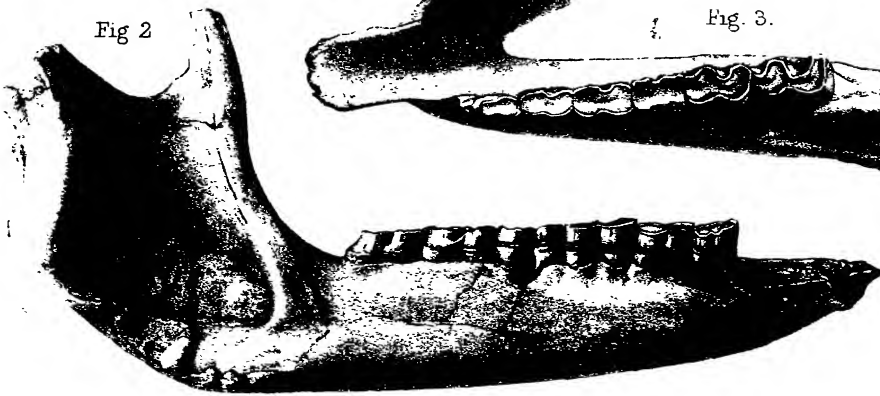


Fig. 3.

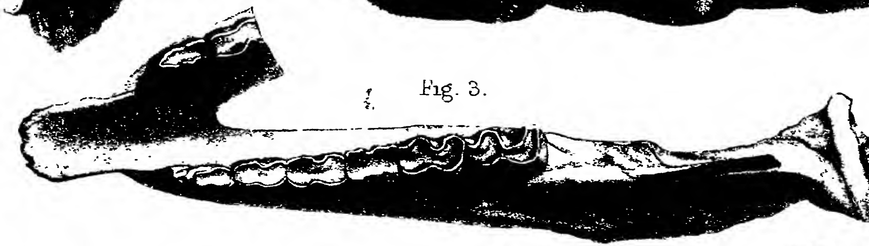


Fig. 4.

Stanghi del. J.Dinkel lith. Rhinoceros Etruscus. W.West imp.

they are vaulted forwards, but not uniformly, as in *R. tichorhinus*; they are bifid at the apex and then throw down a septum which terminates below in a thick knob (Plate XXVI. fig. 1), and is incomplete behind (*vide* 'Dimensions'). The nasal horn is very rough and overlaps the sides of the nasals with an excessively rugous conical raised nucleus; there are no *ramures*, as in *R. tichorhinus* and *R. megarhinus*; the edges of the nasals are thin and arched; the nasal echancrure is narrow at the bottom, and then arches high forwards, followed below by a rim on either side of the septum.

6. The zygomatic arches in front are nearly horizontal; then the posterior part rises upwards in the arch to the glenoid surface, but not nearly so much as in *R. megarhinus*. (In the detached maxillary and orbitary fragment there is a distinct post-orbital tuberosity defining the orbit behind.)

7. The temporal fossæ are very much as in Cuvier's fig. of *R. tichorhinus*, fig. 5, Pl. IX. *Rhin.*; and in the two-horned Sumatra Rhinoceros, fig. 3.

8. The incisive bones join on to the septum, but are broken. (In the right maxillary specimen, 2·2 inches of diasteme remain.) There are no upper incisors apparent, as certainly there are none in the lower jaw.

9. The orbit is placed mostly above the seventh molar, but its anterior border advances as far as the middle of the sixth or penultimate molar in the large skull. (In the right maxillary fragment it advances only to the rear part of the sixth molar; the same remark applies to the skull in two pieces.)

10. The suborbitary foramen is situated between the third and fourth premolars in the large skull. In the maxillary fragment of the head in two pieces it is over the fourth premolar, close to the nasal echancrure between third and fourth premolars.

11. The auditory foramen is large and in a line with the upper edge of the zygomatic arches.

Viewed above, the skull is very like that of *R. tichorhinus*, but it is not so wide and the nasals are more elongated. The interval also between the orbits is narrower, and the cerebral portion longer. The temporal fossæ are of considerable extent; their bounding edges being less defined than in *R. tichorhinus*; they are nearly parallel in the middle, but diverge into the occipital crest behind, and into the orbits in front, as in *R. tichorhinus*. The frontal tableau is longer and less pronounced; it is less broad than in *R. tichorhinus*, but wider than in *R. Indicus*. There is no hole with *ramures* to the nasal horn. The occiput is inclined in front with two diverging ridges and a deep depression; but is shelved over by the projecting crest.

Measurements of the Rhinoceros Skull and Lower Jaw, at Florence.—SKULL.—Length of 6 last molars, right side, 8·8 in. Length of 3 last (true) molars, right much worn, 5·0 in. Length of 3 premolars, 4· in. Total length of skull from occipital lateral crest, measured along chord to overhanging tip of nasal, 25·25 in. Total length of ditto from posterior surface of occipital condyle to tip of nasals (vertical plane), 25· in. Total length from nasal echancrure left side to tip of nasals (by callipers), 7·7 in. Total length from nasal echancrure (left) to anterior border of orbit (exactly), 4·5 in. Total length from anterior border of right orbit to occipital crest (lateral), 14·0 in. Total length from anterior border occipital foramen to palatine echancrure, 12· in. From palatine echancrure to tip of nasals, 12· in. Greatest width across zygomatic arches in line with articular surface, 12·75 in.

Extreme length of right temporal cavity taken at base of skull, 5·2 in. Greatest width of ditto between pterygoid and inside of zygoma, 4·4 in. Greatest constriction of skull between zygomatic arches, 4· in. Length from posterior surface of occipital condyle, to apex of pterygoid alar process, 9·4 in. From ditto to posterior boundary temporal fossa below (edge of articular), 6·4 in. Length of diasteme remaining, right side, 1·5 in. Interval of palate between p.m. 2, 1·5 in. Interval between outer surfaces (posterior end) of p.m. 2, 4·7 in. Interval between anterior barrels of last molars, 2·5 in. Interval between outer surfaces of ditto, 6·6 in. Transverse extent of articular surface of glenoid, 3·9 in. Stretch across condyles to outer border, 5·2 in. Height of occipital crest, right side, from lower surface of condyle, 6·5 in. Height of right styloid (left a little broken), about 2·1 in. Interval between ditto, inside, at apex, 3·8 in. Length from palatine echancrure to posterior edge pterygoid alæ at base, 5·8 in. Length from posterior surface condyle to posterior surface of last molar, 11·6 in. Constriction of skull below auditory foramina, 7·1 in. From anterior border, right orbit, to tip of nasals, about 12·5 in. Length of zygomatic arch from posterior fang of 6th molar or penultimate, in a line with anterior margin of orbit, to border of auditory foramen, approximatively, 10· in. Antero-posterior extent remaining of septum, upper margin, 4·7 in. Antero-posterior extent remaining at middle, about 4·2 in. Width of brow between orbits (right half, 4·5), 9·0 in. Interval between sincipital ridges in line with ear, 2·5 in. Width of nasals in middle of anterior horn at base, 4·45 in. Width of nasals in line with echancrure, 4·25 in. Height from diasteme to edge of nasal arch, 3·9 in. Length from posterior angle (tuberosity) of right orbit to occipital crest, 11·4 in. Height of skull from right condyle to right occipital crest, 6·5 in. Width of occiput near the apex, 6·3 in. Vertical height, right orbit, 2·1 in. Diameter of ditto from post-orbitary process to anterior border (obliquely), 2·7 in. Height of septum from upper surface of incisives to nasal arch, at one inch from premolar, 2·5 in. From tips of nasals to suborbitary (posterior orbit) apophysis, about 15· in. Interval between inner borders of glenoid surfaces, 6· in. Width of zygomatic arches outside, in line with anterior boundary of temporal fossa, left, (end of last molar), 10·1 in. Width of ditto at middle, 11·5 in. Greatest width in line of glenoid surface, 12 2 in. Height of frontal chord at middle of frontal horn (chord stretches over apex of horn), 1·5 in. Height of frontal chord behind ditto, 2· in. Height between horns in middle, 1·8 in. Height in line with posterior boundary of temporal fossa, 1·1 in. Height of chord from middle of occipital crest to smooth surface at posterior boundary of front horn, at middle, 0·55 in. Height of chord from ditto to between horns, ·45 in. Height from ditto to behind the horn depressed (broken?) 1·3 in. Width of maxillary over last premolar, 6·7 in. Width of ditto at commencement of zygomatic arch, 9·7 in. Greatest width of zygomatic arches, 13·2 in. Greatest thickness of nasals to salient point of disc knob, 2·9 in. Medium thickness of ditto to base of conical knob, 2·15 in. Height of septum from tuberosity in front and below to edge of nasals, near tips, 3·3 in.

Lower Jaw (see Plate XXVII).—Entire length of jaw, from posterior margin of ascending ramus to symphysis, 19·25 in. Height of ascending ramus to top of coronoid, 10· in. Breadth of ascending ramus, 5·4 in. Length of line of molars (six last), 8·5 in. Length of three last molars, 4·9 in. Length of three premolars, 3·5 in. Length of last true molar, 1·55 in. Length of penultimate ditto, 1·6 in. Length of antepenultimate, 1·5 in.

Florence, 20th May, 1859.

The Florence Museum also contains a palate specimen of a young *Rhinoceros Etruscus*, showing on the right side the four milk molars emerged, of which the first three are very slightly affected by wear, the fourth is hardly emerged from the gum, and is in a state of germ. The second and third have each a small intercolumnar tubercle, but no basal *cingulum* sweeping round the inside of the barrels. On the left side there are only the first and second milk molars, with the anterior part of the third.

Dimensions.—Length of the four teeth, 5·7 in. Length of first, 1· in. Width of ditto, ·08 in. Length of second, 1·5 in. Greatest width of ditto, 1·3 in. Length of third, 1·8 in. Width of ditto, 1·6 in. Length of last, 1·9 in.

Another fine palate specimen in the same Museum is a little more advanced in age, showing on the left side the four milk molars, in place, and all more or less worn, together with the germ of the first true molar not out of the gum. On the right side there are only the last four of these teeth. The three anterior milk molars are worn nearly in the same degree; the first, being the least worn, shows three distinct fossettes; the second also shows three fossettes, the middle one of which is caused by the confluence of the 'crochet' with the outer combing plate. Both these teeth show an intercolumnar tubercle, and the crochet forms a very open angle with the hind barrel; the same is the case with the last milk molar, which shows no intercolumnar tubercle. None of these milk molars have any internal basal *cingulum*; the intercolumnar tubercle is most pronounced in the antepenultimate or second.

Dimensions.—Length of four milk molars, 5·8 in. Length of first, 1·1 in. Length of second, 1·5 in. Length of third, 1·7 in. Width of ditto in front, 1·7 in. Length of fourth, 1·9 in. Width of ditto in front, 1·7 in. Length of first true molar, 2· in.

All these specimens are labelled 'Rinoceronte a parete internasale, ou Rhinoceros tichorhinus, Cuvier.'[1]

IV.—Memorandum of Remains of Rhinoceros Etruscus, etc., in Museum at Pisa. (See also Plate XXV. figs. 5, 6, and 7.)

22nd May, 1859.

The cast of the skull of the Rhinoceros with the partial septum is not of *R. hemitœchus*,[2] but of the Val d'Arno species (*R. Etruscus*). The original, which has since been much mutilated, is still preserved in the Florentine Museum. The cast is wonderfully perfect in what concerns the septum, which is distinctly limited to the anterior half, and terminates in a thickened portion united to the incisive bone. (See Pl. XXVIII. fig. 1.)

The posterior part of the skull is wanting. On one side there are no teeth, but on the other the premolars and one molar remain. The teeth are worn low, but in the remaining molar the crochet is thick, and at somewhat of an acute angle. There is both a nasal and a frontal horn, and the nasal disc is very rugous. Saw also several lower jaws of Rhinoceros, some of them evidently of the '*R. Valdarnensis*.'[3] Another, much larger, and said by Prof. Meneghini to be from the Val d'Arno, is certainly of another species, and probably of *R. megarhinus*.

Pisa, 1st June, 1859.

Examined a very fine specimen of the right ramus of lower jaw of *Rhinoceros*. The six last molars are in place, and the posterior five are entire; the crown of the anterior molar is broken off. The ascending ramus is broken vertically through the sigmoid echancrure, so that the condyle and angle are missing, but the coronoid is perfect to the very apex, and compares beautifully in its greater dimensions, especially in breadth, with that of *Rhinoceros Etruscus*. The coronoid rises very vertically.[4] The teeth are all emerged and are very perfect; the cres-

[1] See *antea*, p. 314.—[Ed.]

[2] As stated in a previous note, and at page 332.—[Ed.] [3] *R. Etruscus.*—[Ed.]

[4] Dr. F. seemed to infer that this was the lower jaw of *R. megarhinus*. See page 356, line 13; and page 369, line 6.—[Ed.]

cents of the first true molar are still distinct; those of the last are but slightly affected by wear. The specimen was found in the Collines of St. Regolo.

Dimensions.—Total length of specimen, 15· in. Length of line of 6 molars, 9·6 in. Length of ditto of 3 premolars, 4·1 in. Length of 3 last molars, 5·7 in. Height of jaw under penultimate premolar, inner side, 3·2 in. Height of ditto under penultimate molar, inner side, 3·9 in. Height to apex of coronoid, 10·5 in. Width of apex of ditto, at sigmoid, 1·7 in.

V.—Note on a Specimen of Rhinoceros Etruscus, belonging to the Marchese Carlo Strozzi.

Leghorn, 2nd June, 1859.

This is a magnificent specimen of a symphysial portion of a lower jaw with part of the two rami. The rami are broken obliquely, so that only the fangs of two molars are seen in the section. The incisive border is obtusely bifid, with a very pronounced sinus above and behind each of the lobes. There is a narrow alveolar pit, as for an incisor that has dropped out. The symphysial portion is very carinate below, and is completely drilled by large mentary holes, nine on right side and seven on left. Seven of the nine holes on the right side are close together. This is an invaluable specimen.

Further Note on same Specimen—1860.

Mr. Dinkel's drawing is good (See Pl. XXVIII. figs. 2, 3, and 4). It shows on the right side the fangs of the anterior premolar, and of the next adjoining tooth. Mr. Dew's cast[1] is chiefly defective in the great size he has given to the incisive pits, especially on the left side, both in length and in antero-posterior diameter; the cast also makes them unsymmetrical, which they are not. Dinkel's drawing represents the pits accurately. They are evidently the pits of a small shed incisor.

Dimensions.—Extreme length of fragment, left side, 7·3 in. Length of diasteme, right side, 2·5 in. Length of symphysis, at middle, 1·3 in. Width of symphysis at middle of diasteme, 1·75 in. Greatest width of ditto at protuberances below, 1·85 in. Width of ditto at incisive pits, 1·4 in.

VI.—Description of Upper Jaw of Rhinoceros Etruscus, from Malaga.

The specimen consists of the greater part of a right upper maxillary bone, comprising *in situ* the second and third premolars, and the three true molars. The last premolar (p.m. 4) is wanting. The specimen has been fictitiously repaired with cement, placing all these teeth in series, without allowance for the missing premolar, and it is in consequence deceptive at first sight. The outer border of the crown is more or less damaged in most of the teeth. Together with Mr. Waterhouse, to whom I referred the fossil, I was at first led to believe that it belonged to the miocene *Acerotherium incisivum* of Kaup, from its close general resemblance to the specimen figured by De Blainville in the 'Ostéographie' (*Rhinoc.* Pl. XII.), under the name of *Rhinoceros incisivus d'Auvergne.* But I have since arrived at the conclusion, after a fresh examination of the Tuscan collections, that the Malaga Rhinoceros is the *Rhinoceros Etruscus*, so named by me from its prevalence in the Pliocene deposits of the Upper Val d'Arno. This form has hitherto been confounded, on the one hand with *Rhinoceros tichorhinus*, and on the other with *R. leptorhinus* of Cuvier. It had a bony nasal septum,

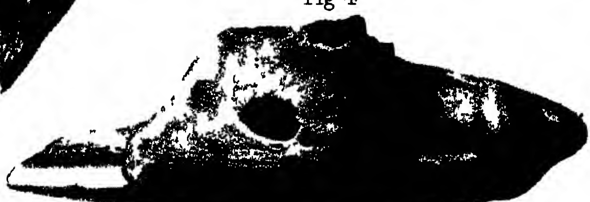
[1] Now in British Museum.—[Ed.]

Fig 1

Fig 2

Fig 3

Fig 4



J Dinkel & Pierucci del

Rhinoceros Etruscus

W West imp

as in the Clacton form, described in the 'British Fossil Mammalia,' under the designation of *Rhinoceros leptorhinus*, from which, however, it is essentially distinct in every detail throughout the construction of the skeleton.

The true *Rhinoceros leptorhinus* of Cuvier, founded upon the Cortesi cranium, had no ossified nasal septum, and is distinct alike from the species here called *Rhinoceros Etruscus*, and from the fossil Rhinoceros of Clacton. I have ascertained that the character of an ossified nasal septum was common to three European fossil species of Rhinoceros, of the Pliocene and newer Pliocene periods; and that there is only one known species of this category in which it was wanting. The characters of these species, and their distribution over the European area, will be described in detail in a separate essay.—H. F., *Oct.* 1859.

[The above description appeared as an appendix to a paper by Professor Ansted in the 'Quarterly Journ. Geol. Soc.,' for Feb. 1860. The maxilla with portions of vertebræ were found a few miles from Malaga in white marl, overlying Pliocene blue clay, abounding with shells. The following details of a comparison of the specimen with others in the British Museum is extracted from Dr. Falconer's Note-books.—Ed.]

British Museum, 16*th August*, 1859.

Brought with me to-day Ansted's specimen from Malaga, and compared it again with:—1. Kaup's *Acerath. incisiv.*, a cast of the old palate figured in the 'Oss. Foss. de Darmstadt;' 2. Kaup's cast of entire cranium of ditto; 3. De Blainville's *Rhinoc. incisiv.* of Auvergne, cast figured in 'Ostéogr.,' Pl. XII.; 4. Lartet's *Rhinoc. Simorrensis*; 5. Duvernoy's *Rhin. pleuroceros*, cast; and 6. Lartet's *Rhinoc. brachypus*, *Acerath. Goldfussi*—all *Aceratheria*.

Observed the following constant characters:—1. In *Acerath. Goldfussi*, the last molars even have a basal bourrelet all round, most strongly marked in the penultimate.

2. In all the *Aceratheria*, the base of the crown outside presents an angular bulge, a rudiment of what is seen in *Palæotherium*. This is very strongly marked in a beautiful specimen of Lartet's *Rhin. Simorrensis*, a skull with the palate and teeth on both sides (7 on left, only 6 on right); it is also very strongly marked in Lartet's *Acerath. brachypus*, the British Museum specimen of which is made up of teeth of different individuals. It is also well marked in the cast of Duvernoy's *Rhinoc. incisivus* of Auvergne, and very marked in the penultimate of Kaup's old palate specimen and in the skull cast.

3. The anterior outer vertical angle and groove are very boldly defined in all the *Aceratheria*, and the angular projection is very broad; but from that forwards the surface is nearly smooth, and without the undulated swelling seen in *Rh. megarhinus* and the *Rh. tichorhinus*, &c.

4. In Lartet's *Rhin. Simorrensis*, which is of an adult with all the teeth worn except the last, and is in the best stage of wear, besides the projection of the crochet from the back barrel, there is a constriction of the anterior barrel, which when worn forms a well-marked emargination, so that a lobe of the anterior barrel projects into the valley like a kind of anterior crochet; but overlapped by the true crochet, *i.e.* nearer the inside. The same thing is observed in the penultimate and antepenultimate of Kaup's cranium of *Acceratherium*, in his old palate specimen figured in the 'Oss. Foss. de Darmstadt,' and in De Blainville's Rhinoceros of Auvergne—*i.e.* in the last premolar and penul-

timate true molar. This anterior crochet survives when the true crochet is worn out; this is seen in De Blainville's drawing of the penultimate, which shows a kind of trefoil to the anterior disc.

5. In *Acerath. Goldfussi*, the posterior tubercle forms a long crenulated '*gradus*,' most salient at the outer end; the same is seen in Lartet's *R. Simorrensis* and in Kaup's *Aceratherium*. The ridge is confluent inside, free and high outside (like the bourrelet in the Mastodons.)

6. The mouth of the valley of the last molar is very open, and will admit the forefinger easily.

Compared the Malaga specimen, after making these observations, and remarked the following peculiarities:—

1. The last true molar behind has only a moderate tubercle, as in the Tuscan specimens, and has no 'gradus' ridge at base behind.

2. The mouth of the valley is comparatively narrow; in the last molar it will not admit the finger as in De Blainville's Auvergne specimen; the anterior barrel is broad and has a crochet constriction.

3. Unfortunately the apex of the outer ridge-summit of the crown is broken in the three last molars, but what remains of the low crown presents an undulated surface.

4. There is no true constriction of the anterior barrel, which in the antepenultimate is very broad.

5. There is a duck's bill pattern to the termination of the posterior valley, with an accessory plate forming a reniform outline, as in *Aceratherium*, but no subdivision of the crochet into plates in any of the teeth.

6. The most important and marked difference is that the second premolar (p.m. 2) has no disc of pressure in front—no p.m. 1! p.m. 3 has two fossettes and the anterior inner cone (barrel) is isolated all round by a deep fissure and gives a narrow ovate disc.

7. There is a basal bourrelet to p.m. 2 and 3, but not very marked.

8. The basal bourrelet to the premolars of the Auvergne specimen forms actually a sharp raised rim; the bourrelet is very little pronounced in comparison in the Malaga specimen, in which it does little more than make a bridge between the barrels, while in the Auvergne specimen it sweeps round the anterior barrel, rising obliquely in the posterior.

I infer the specimen to be of *Rhinoceros Etruscus*.

Dimensions.

	Ansted's specimen from Malaga	De Blainville's Auvergne palate
Joint length of three last molars	5·5	5·55
Joint length of 2nd and 3rd p.m.	2·9	2·8
Length, outer edge of p.m. 2	1·4	1·35
Width of ditto behind	1·55	1·6
Length of p.m. 3	1·6	1·5
Width of ditto, outer	2·	2·05
Length of t.m. 1 in middle	1·8	1·55
Greatest width in front	2·1	2·18
Length of t.m. 2, outer	2·15	2·1
Length of ditto, middle	1·9	1·85
Width in front at base	2·3	2·25
Length of t.m. 3, from tubercle to outer bourrelet	1·9	1·9

VII.—Description of Cranium with Teeth, Humerus, Tibia, and Fibula, in the Museo di Storia Naturale della R. Università, at Bologna.

13th May, 1861.

'Modello in gesso dell' intera regione palatina delle ossa mascellari, colla doppia serie dei molari quasi interi di un grande Rinoceronte fossile piuttosto giovine, e probabilmente della specie denominata dal Cuvier *Rhinoceros leptorhinus*. L'originale dal quale si è cavato questo modello fu trovato a poca distanza da Barberino del Mugello in quella stessa località dove furono rinvenuti gli altri denti e mandibule di Rinoceronte che si conservano nel Gabinetto sotto i no. 2,381, 3,450, 3,758, regulati dal veterinario di quel paese Signor Onorio Da Barberino. Vedi per il pezzo ora descritto la di lui lettera che si conserva nel museo sotto questo numero. La forma onde ottenere questo modello è stato levata dall' originale con tutta diligenza dal modellatore dei Gabinetti Anatomici dell' Università Signor Giuseppe Astorri.' [1]

Description of the original specimen in the Bologna Museum, to which the above memorandum applies.—Rhinoceros Etruscus, Pl. XXIX.

This specimen (represented in Pl. XXIX.) consists of the maxillaries on both sides, with part of the zygomatic arch of the left side, the palate, the palatine echancrure, with the entire series of molars on either side in the finest state of preservation. The cranial portion is broken off behind the palatine bones, and all of the facial part of the chaffion is broken on both sides in a line a little above the upper margin of the zygomatic arches; the lower boundary of the nasal echancrure to the bottom is perfect on the left side, and nearly so on the right. The left suborbitary foramen is distinctly shown; that on the right side is broken and concealed by an attached portion of distinct bone, enveloped in (*Sansino*) matrix. There remains in the front of the series of molars about $2\frac{1}{2}$ inches in length of the diastemal beak; but no indication of the descending portion of the nasal septum, the position of which is occupied by (*Sansino*) matrix.

The dentition, as regards the age of the molar teeth, is in the most perfect state to give the dental characters of the species; the antepenultimate true molar being but slightly worn, the penultimate less so, and the last true molar but very slightly affected by wear. Some of the crowns are more or less damaged, but what is wanting from this cause on one side is happily supplied on the other. The teeth belonged to an animal that was perfectly adult, but not aged; the three last premolars are beautifully seen on the left side; on the right there is most happily preserved the alveolus (triple) of the pre-antepenultimate premolar, which had dropped out, and the antepenultimate at its front edge shows distinctly the disc of pressure of the fallen tooth. It is therefore clear that there were seven molars in the adult state, viz. 4 premolars and 3 true molars. The following are the principal dimensions:—

[1] Il pezzo originale è stato poscia acquistato pel Gabinetto dal lodato Signor Da Barberino pel tenue prezzo di romani scudi quattro, e si conserva sotto questo stesso numero nel museo, dove fu depositato in Marzo del 1847, con altre ossa fossili scavate nella stessa località.

Extreme length of the line of 6 molars on the left side, measured from the base outside of the penultimate p.m. to the posterior boundary of the rudimentary pit at base of last molar, 9·1 in. Length of ditto on right side from anterior margin of alveolus of dropped first premolar to posterior boundary of last true molar, 9·5 in. Length of last three premolars, left side at top of crown, outside, 4·3 in. Length of three true molars to posterior boundary of last, left side, 5·4 in. Length from the antepenultimate p.m., right side, to the posterior margin penultimate true molar (to correspond with the Pisa cast), 7·7 in. Length of antepenultimate p.m. left side, top of crown outside, 1·35 in. Extreme width at base of ditto, behind, 1·6 in. Length of penultimate ditto ditto, left side, 1·55 in. Greatest width of ditto in front at base, 2· in. Length of last premolar in front at left side, 1·6 in. Greatest width of ditto in front at base, 2·1 in. Length of crown of penultimate true molar (1·95, right side), 2· in. Greatest width of ditto at base in front, right, 2·2 in. Length of crown of ditto at base inside, 1·5 in. Length of crown of penultimate true molar, right, outside, 2· in. Length of crown of ditto, inner side, at base, 1·5 in. Greatest width at base in front of ditto, 2·2 in. Antero-posterior diameter last true molar, left side, from anterior bourrelet, in front, to posterior boundary of basal valley behind, 1·8 in. Transverse diameter of ditto, in front, at base, 2·1 in. Interval between the anterior barrels of antepenultimate premolars, 2·05 in. Interval between anterior barrels of last premolar at base, 2·8 in. Interval between anterior barrels, first true molar, 3· in. Interval between anterior barrels of penultimate true molar, 2·1 in. Interval between anterior barrels of last molars, 2·85 in.

MEMO. The above dimensions give the width of the palate.

Length of diasteme in front of pre-antepenultimate premolar, right side, 1·75 in. Interval between the diastemal ridges in front of first premolar, 2·1 in. (These comprise the principal dimensions of the teeth.) Height of zygomatic arch, left side, 1·8 in. Width of zygomatic fossa, left side, 3·5 in.

Description of the Teeth on right side.—There were 4 premolars. This is distinctly shown on the right side by the triple fang-pits of the pre-antepenultimate or p.m. 1, viz. one in front and two separate ones behind: they are more or less filled up.

P.m. 2, the antepenultimate premolar, is quite entire on both sides, and in nearly the same stage of wear. The discs of the two inner barrels are distinct, and nearly of the same size; the anterior barrel does not form an isolated compressed cusp-shaped cone, as in Gervais' drawings of *R. leptorhinus*. The disc forms a very compressed oval, which is not confluent with the outer longitudinal disc. The disc of the posterior barrel is wider, and it is connected by an isthmus with the disc of the outer ridge, forming a kind of gourd-shaped outline. The disc of the outer longitudinal ridge is not much advanced in wear, being where broadest but 0·4. The posterior valley is nearly quadrangular in form and well defined, the posterior boundary being quite intact. The great middle valley forms a large triangular fissure, into which crochet processes are intruded from behind forwards. There is a distinct cingulum to the base at the inside, but not in strong relief, not so much so as the anterior talon. The outer surface of the crown is convex, antero-posteriorly.

P.m. 3, the penultimate premolar, right side. This tooth resembles in form the antepenultimate, but is larger and more advanced in wear. The discs of both barrels being confluent with the outer disc, it is much broader in front than behind. The anterior outer vertical furrow is well marked, the posterior valley is very much as in p.m. 2. The great middle valley forms a large fissure which is divided into two portions by the crochet processes, and an outer accessory plate is intruded from the longitudinal ridge; one little ring of enamel is isolated on the base of the crochet.

The penultimate premolar is equally perfect on both sides, and in the same stage of wear. They both show the basal bourrelet round the inner barrels, but not very pronounced.

P.m. 4, or the last premolar, has the anterior outer angle of the crown broken on the right side; it is beautifully perfect on the left, which shows the crown but very slightly advanced in wear; the discs of both barrels are confluent with the outer disc. The posterior valley is well defined and intact behind; the anterior transverse valley has intruded into it a large crochet process, and two large accessory plates (or combing processes), proceeding parallel to each other from the outer ridge, and converging towards the crochet. A distinct ring of enamel isolating a pit is situated on the base of the crochet, the whole causing a complex pattern to the convolutions of the transverse valley. Fine parallel and wavy grooved lines of enamel are beautifully shown on the inner surface of the enamel. This tooth, like the others, shows a distinct basal cingulum; it is more triangular in form than the two which precede it.

T.m. 1, the first true molar, is quite perfect on the right side; on the left side the posterior barrel is broken on its inner surface. The crown is more advanced in wear than any of the others, but still not very much so, being not yet half worn. The posterior valley is quite intact behind, but is narrower and more vertical than in the premolars. The transverse valley is divided into two nearly distinct portions by a very thick crochet, protruded from the posterior barrel; the outer division has no accessory plates intruded into the fissure from the outer longitudinal ridge; the inner division forms a narrow triangular fissure. The crochet is emitted at a very open angle from the posterior barrel, more open even than in *R. leptorhinus*, and totally different from that seen in *R. hemitœchus*. There is a little basal mammilla between the barrels at the inside, but not a trace of an anterior basal bourrelet to the anterior barrel. The teeth are very much alike on both sides. The central termination of the middle valley does not exhibit the duck's head pattern, figured by Gervais and De Christol in the teeth of *R. megarhinus*. There is a little tendency to the peculiar twist of the posterior barrel near the apex of the crown; the anterior outer vertical groove is broad, but shallow; the angle boldly overlaps the last premolar.

T.m. 2, or the penultimate, on the right side, is nearly perfect, but the outer anterior angle is broken off vertically on the left side. The tooth in general form resembles very much the antepenultimate just described, but is less advanced in wear; the crochet is also, as in it, emitted at an open angle. The transverse valley is divided in two by the crochet, the inner division being triangular, without any accessory plates or complication whatever. The summit of the posterior barrel has the peculiar compressed contortion well marked. The crochet advances nearly into contact with the anterior barrel; the discs form narrow bands of wear, which are confluent throughout. There is not a trace of a basal cingulum on either side.

T.m. 3, or the last true molar, is broken partly on both sides, but in different directions, so that what is wanting in the one is supplied by the other. The crown is but very slightly affected by wear on the right side. It is of a distinct triangular form, all the parts converging to a

contracted summit. The anterior barrel has a distinct basal bourrelet, which is wanting in the posterior. The transverse valley is divided into two parts by a crochet, advancing on the right side to meet an accessory plate emitted from the anterior barrel. On the left side, these two plates overlap. On the right side, an accessory plate is also given off from the outer ridge, converging towards the crochet. The most striking character about the tooth is, that, as in *R. hemitœchus*, there is a distant rudiment of a posterior valley restricted to the base, but not forming a well-defined cup with a distinct rim, as in that species. This rudiment is distinctly shown on both sides, bounded posteriorly by a basal cingulum. The basal bourrelet behind the posterior barrel of the last true molar has barely emerged above the alveolar margin.

The enamel is smooth in all these teeth, and marked by beautiful, fine, wavy, horizontal lines. There is not a trace of general superficial rugosity, and not the slightest indication of a layer of cement.

The outer surface of the enamel is traversed in a dendritic fashion, by fine channels, like those which are attributed to the work of Marine Sponges, but the formation out of which this specimen came is fresh water.

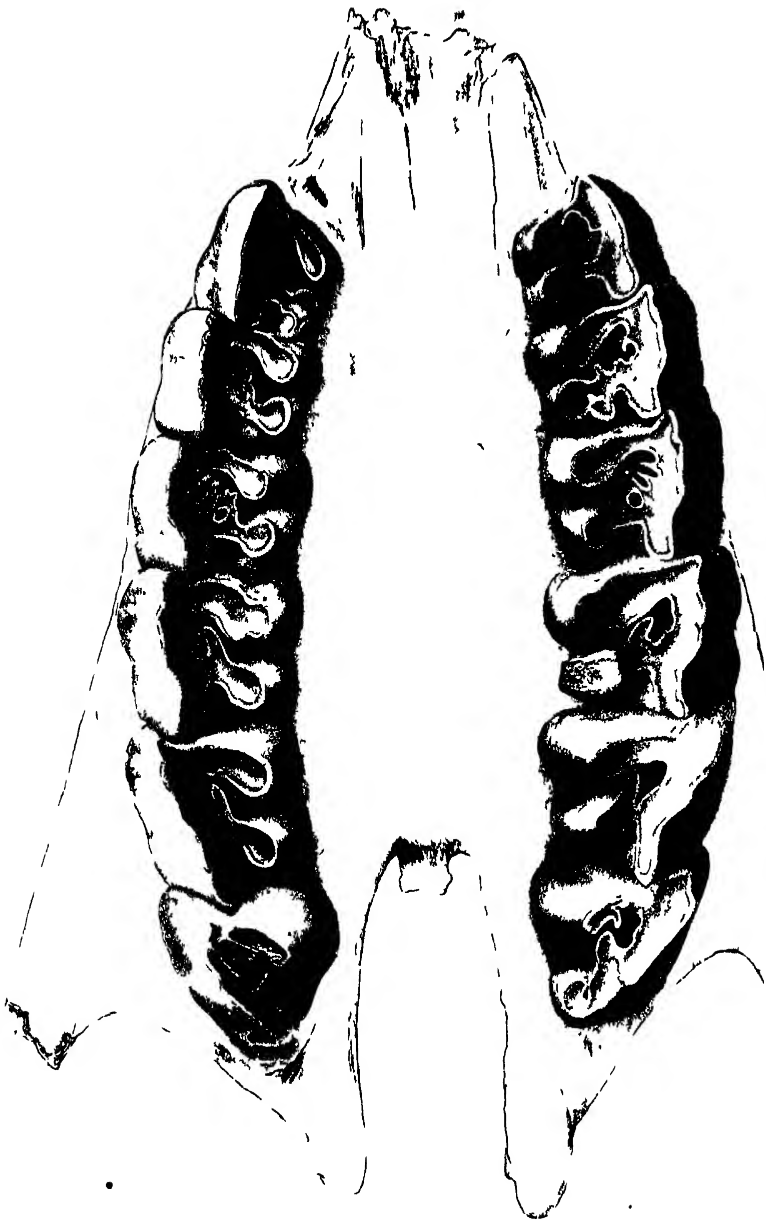
The bottom of the palatine echancrure comes in a line with the middle of the posterior barrel of the penultimate true molar, and the suborbitary foramen is immediately over the line of junction between the penultimate and last premolars. The disc of the crochet of the penultimate true molar is nearly as broad as that of the posterior barrel, the crochet being very thick and simple. The anterior outer vertical furrow is well pronounced in all the molars, from the penultimate premolar to the last true molar inclusive. It is wide and shallow, but the other vertical hollows are but very slightly pronounced by an undulation of the surface. There is not the slightest indication of an outer basal bourrelet, as seen in the *Acerutherium incisivum* of Kaup, the outer surface being smooth, and nearly vertical throughout.

Besides the above, there are casts in the Bologna Museum of several of the principal specimens of Rhinoceros figured by Nesti, and a duplicate cast of the Targioni Tazzetti cranium of the Florence Museum, made by Savi for Pisa, and of which I got drawings. There are also casts of the following bones:—A humerus, left side, very closely resembling the figs. 1 and 2 of Cuvier's Pl. X. *Rhin.*, but more perfect, of which the following are the dimensions:—

Extreme length from top of tuberosity to tuberosity of outer condyle, 16·25 in. From articulating head to middle of inner condyle, 14· in. Width of articular surface of condyles, 3·4 in. Greatest width at inferior end, 5·2 in. Antero-posterior diameter of inner condyle, 4·1 in. Greatest width of shaft at middle of median tuberosity, 5·1 in. From sinus, at lower margin of middle tuberosity, to top of great tuberosity, 7·2 in. Greatest constriction of shaft, below middle tuberosity, 2·2 in. Antero-posterior diameter of articular head and tuberosity, 4· in. Transverse diameter of articular head, about 3·7 in.

Specimen of tibia and fibula, figured by Cuvier, Pl. XI., *Rhin.*, fig. 15.

Extreme length of tibia at middle, about 14· in. Transverse diameter of upper articulating surface, 4·4 in. Antero-posterior ditto to inner margin of inner articular surface, 4·8 in. Transverse diameter, lower articular head, including fibula, 4·3 in. Antero-posterior diameter, inner articular cup, lower end of tibia, 2·8 in. Extreme length of fibula, 12·25 in. Transverse diameter of shaft of tibia, at middle, 2·3 in.



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Rhinoceros Etruscus
(Bologna)

W West imp

Cast of right femur, figured by Cuvier, Pl. XI. *Rhin.*, fig. 19, of which the upper articulating head is wanting

Extreme length taken at the middle, 16·50 in. Antero-posterior diameter of inner condyle and pulley, the latter partly broken, 6· in. Length of pulley in middle, 2·5 in. Transverse diameter of ditto, 2·5 in. Least transverse diameter of shaft below the middle trochanter, 2·5 in. Vertical height of neck of middle trochanter, 2·1 in. Transverse diameter of shaft, including middle trochanter, at middle of ditto, 5·2 in. Width of bone at middle of sinus above middle trochanter, 4·1 in.

All these bones belong to *Rhinoceros Etruscus*, and there are still preserved in the Bologna Museum, the originals of the specimens represented by Cuvier, figs. 5 to 10, inclusive of Pl. X., *Rhin.*, of 'Os. Fossil.' These are the upper and lower extremities of a humerus of the same species (*R. Etruscus*), stated to have been procured by the Ab. Ranzani in France.

VIII.—Description of Specimens of Rhinoceros Etruscus at Le Puy.

Le Puy, 15th September, 1863.

In the Museum of Le Puy there is a magnificent series of remains of the skeleton, consisting of three feet, with all the bones *en suite* to the terminal phalanges—the tibia, fibula, astragalus, and articular head of the femur. The shaft of the femur with the third trochanter is exactly as in Pentland's specimen in the British Museum. There are also two detached calcanea, both of the left side, and one astragalus. All are from Solilhac.

In the same Museum there is also a series of the molars of *R. Etruscus*, six right and left, but detached and separate, with the last molar just coming into use, and in the finest condition for figuring. They are from Vialette. In addition there is a superb specimen of the left ramus of the lower jaw of *R. Etruscus*, having the four last molars *en suite*, all a little worn, and the hind portion of the penultimate premolar; the teeth are in a beautiful condition to be drawn.

There is also the muzzle of the lower jaw of *R. Etruscus*, perforated below exactly like the specimen of Carlo Strozzi (see page 360), and with the empty pits of two small median incisors more round, more pronounced and less angular than in Strozzi's. There is no keel below, as in the Florence specimen. The specimen is red, heavy and ferruginous, and in the same mineral condition as the Vialette lower jaw.

Dimensions of Lower Jaw, left, from Vialette.—Length of fragment, 11·5 in. Length of series of four molars, 6·75 in. Length of last true molar, 1·75 in. Length of penultimate, 1·65 in. Length of antepenultimate, 1·62 in. Length of last premolar, 1·50 in. Height of jaw at posterior edge, last molar, 3·35 in. Height at anterior edge of first true molar, 2·9 in. Height at anterior edge of last premolar, 2·65 in.

The inferior border is perfectly straight along the three true molars; there is no curve, but there is a strong longitudinal channel along the middle of the inner side; and to each of the anterior barrels of the four molars there is an oblique descending bourrelet, strongly marked. The jaw is truncated along the ascending ramus and in front. The specimen ought to be figured.

15th September, 1863.

Masel, near Le Puy, with Messieurs Pichot, Robert, and Lartet. Jaw of *Rhinoceros Etruscus* found by M. Pichot at Sainxelle, near St. Anne.

There is also a magnificent head, very well preserved, of *Rh. Etruscus*, with the series of molars (six) of the two sides present. The anterior portion is entire, and also the bony wall of the nasal partition. The two jaws are slightly broken, and likewise the orbit of the left side. The occipital portion, as well as the condyle, is wanting. The age of the dentition is that which best shows all the characters, the last true molar being very little worn. The three premolars are much affected by wear. The antepenultimate has three fossettes; the echancrure of the first anterior ridge is still apparent, as in the drawing of the Bologna skull (Pl. XXIX.). The penultimate is less worn and has two fossettes, the middle one being divided into two parts; and the crochet is serrated, as in the Bologna jaw. The last premolar of the left side is well worn, and shows three very distinct fossettes, and the crochet is but little denticulated. The first true molar is half worn, the crochet is simple and at right angles, without a combing plate; the median hollow is quite open on the inner side. The penultimate true molar has nearly the same form, but on the left side the crochet is confluent with the anterior ridge, so as to isolate one part of the median hollow which is situated behind, as in the tooth of Crozes; but on the right side the crochet is detached. The last molar is very little worn, with the crochet free, and a plate projecting from the anterior ridge. In form and size it perfectly resembles the cast that I have brought from the Museum at Pisa (Pl. XXV. fig. 5), and the molars (pre- and true-molars) have a basal crown on the inner side. The length of the series of six molars is nearly the same as that in the drawing of the Bologna skull (9·8 in.). The osseous partition and the nasal bones exactly resemble the drawings of the specimens in the Florence Museum, but it seems to both M. Lartet and myself that the osseous partition is less complete.

The jaw is embedded on the left side in tufaceous greenish grey alluvium—the 'Alluv. inter-volcanique' de M. Pichot.

III. NOTES ON RHINOCEROS LEPTORHINUS (Cuv. pro. parte), R. MEGARHINUS (Christol).

I.—Description of Remains of Rhinoceros Leptorhinus (R. megarhinus) in the Museum at Montpellier.

18th November, 1858.

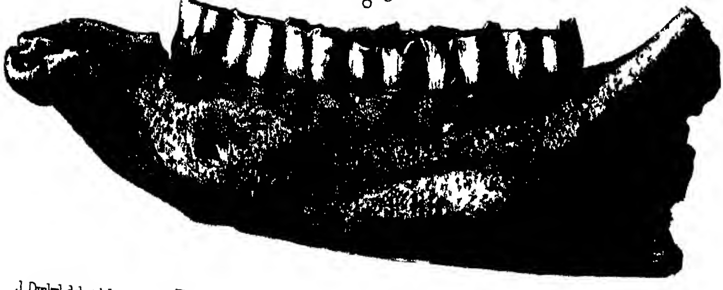
Examined the original of the fine lower jaw of *R. megarhinus* figured by Gervais, and also another lower jaw of the same species more perfect at the muzzle, but mutilated behind. The former is double, and on the right side comprises the whole of the ramus from the tip of the incisive margin on to the condyle and coronoid, the apex of the coronoid being alone wanting. On comparing it with Dinkel's drawings of *R. hemitœchus*, observed the following points of difference (See Pl. XXX.):—

1. The lower edge of the horizontal ramus is nearly a straight line from the angle on to the anterior edge of the first true molar.
2. The low elevation and great thickness of the body of the ramus.
3. The horizontal line (still slightly concave) of the plane of dentrition (very concave in *R. hemitœchus*).

Fig 1

Fig 2

Fig 3



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Rhinoceros leptorhinus (R megarhinus)

4. The great length of the diasteme; the distance from the middle of the incisive border to the anterior edge of the antepenultimate premolar being exactly equal.

5. The absence of reclination in the anterior border of the coronoid. It makes an open curve below with the ramus, but the superior part is nearly vertical.

6. The posterior angle projects behind the neck of the condyle, and is puckered. (The figs. in 5 and 6 of De Christol's thesis very good; his *R. tichorhinus.*)

7. Very long diasteme with sharp raised edges and great constriction of the gutter between them, and then a spathulate expansion in front towards the incisive border; the anterior portion is curved, and throws out a step, but the form is very different from *R. hemitœchus*, and there is nothing of the scaphoid character in the general contour below.

Dimensions.

	R. megar. No. 2	Col. Wood's R. hemitœchus
Length of 6 last teeth	10·5	10·
Length of 3 (last) true molars . . .	6·	6·25
Length of 3 premolars	4·5	3·8
Length of diasteme to incisive border . .	4·4	

In both of Gervais' specimens the teeth are adult: *i.e.* the last are partly worn and the antepenultimate true molar is ground down to a disc. In jaw No. 2, the larger, there are only six teeth (less perfect in the other). In No. 2 there is also a very distinct outer included incisor on the right side, with the alveoli of two middle ones nearly filled up.[1]

II.—Measurements of Skull of Rhinoceros Leptorhinus in the Museum at Lyons.

[On his way to Italy, in 1858, Dr. Falconer was presented by Prof. Jourdan with the cast and an unpublished lithographic engraving of a skull of Rhinoceros in the Nat. History Museum at Lyons, with the following inscription: 'Tête de Rhinoceros megarhinus des sables d'eau douce trouvée par M. Jourdan le 12me Févr. 1856, à Lens Létang, près Moras, Drôme.' This cast was subsequently compared with the Rhinoceros remains in the various museums of Italy, in the descriptions of which it is frequently referred to. There is no description of the skull in Dr. Falconer's Note-books, but the skull and molar series have been reproduced by Mr. Dinkel in Pl. XXXI. figs. 2 and 3, and I am indebted to Mr. W. H. Flower, F.R.S., for his assistance in taking the following measurements of the cast, which is now deposited in the British Museum.—Ed.]

1. Extreme length of skull from summit of occipital crest to point of premaxillary bones, 25·5 in. 2. Extreme length of ditto from posterior plane of occipital condyles to broken edge of left diasteme, 23·3 in. 3. Extreme length of ditto to anterior edge of alveolus of 2nd premolar, 22·4 in. 4. Length from anterior border of right orbit to outer edge of occipital plane, left side, 15·2 in.

[1] Dr. Falconer's Note-book also contains a description of a mutilated skull of *R. megarhinus* (*sic*) in the Bishop's Palace at Montpellier, examined by him on Nov. 21st, 1858. Nearly the whole of the nasal sinus was filled with pebbles and gravel, so that it was impossible to be certain whether or not there was a septum, but Dr. F. was inclined to agree with De Christol and Gervais in thinking there was none.—[Ed.]

5. Length from posterior plane of occipital condyles to posterior margin of last true molar, 12·5 in. 6. Diameter between outer margins of occipital condyles, 4·5 in. 7. Transverse diameter of left condyle, taken near middle, 1·5 in. 8. Vertical height of ditto, 2·9 in. 9. Diagonal diameter of ditto (greatest), 3· in. 10. Greatest width of occipital foramen, 1·7 in. 11. Height of occipital plane to lower surface of occipital condyles, 9·5 in. 12. Greatest width of occipital plane, just above the condyles, 6· in. 13. Greatest width of ditto about middle, 5·2 in. 14. Length of zygomatic fossa, left side, 7·4 in. 15. Length from posterior boundary of zygomatic fossa to posterior surface of left occipital condyle, 7· in. 16. Length from anterior margin of auditory foramen to anterior margin of the orbit, 10·5 in. 17. Extreme length from anterior margin of 2nd premolar to posterior edge of last true molar, left side, 10·5 in. 18. Length of last 3 premolars, left side, 4·7 in. 19. Length of 3 true molars, left side, 6·2 in. 20. Extreme length of 1st and 2nd true molars, left side, 4·25 in. 21. Length of 2nd premolar, left side, 1·55 in. 22. Transverse diameter of ditto near base, behind, 1·7 in. 23. Antero-posterior diameter of 3rd premolar, left side, 1·6 in. 24. Transverse diameter of ditto at base, anterior barrel, 2· in. 25. Antero-posterior diameter of last premolar, outer surface, 1·7 in. 26. Transverse diameter of ditto at base, anterior barrel, 2·25 in. 27. Length of crown of first true molar, outer surface, left, 2· in. 28. Transverse diam. of ditto at base, anterior barrel, 2·6 in. 29. Antero-posterior diameter of penultimate molar, anterior surface, 2·3 in. 30. Transverse diameter of ditto anteriorly, 2·5 in. 31. Antero-posterior diameter of last true molar (greatest), 2·1 in. 32. Transverse diameter of ditto anteriorly, 2·4 in. 33. Interval between diastemal ridges at 2nd premolar (inner surface), 1·2 in.

III.—Note on Rhinoceros Leptorhinus from Ilford.

British Museum, 13th August, 1859.

Compared the cast from Montpellier of the last upper true molar with a specimen labelled 'Tooth of Rhinoceros from Ilford, Essex' (No. 40,482). They are both nearly of the same size and stage of wear and exhibit exactly the same pattern. The Ilford tooth shows still a kind of vertical cleft for the posterior valley, and a very thick layer of cement in the valley.

IV.—Note on Molars of Rhinoceros Leptorhinus? from the Bone Breccia of Nice, filling a Cavern in the Jura Limestone.

Nice Museum, 11th December, 1858.

Of the Rhinoceros the finest specimen is a sixth or penultimate upper molar of the *left*[1] side (Pl. XXXII. fig. 3), but very slightly advanced in wear; unluckily the anterior outer angle is broken off, as far as the middle of the great valley; but the tooth shows in section the step of the anterior external vertical groove very pronounced, the whole of the great middle valley, the anterior basal bourrelet, the posterior valley sheeted over with a very thick layer of cement, the anterior and posterior barrels inside entire to the apex, and the crochet quite entire. The enamel is rugous on the outer surface, with vertical striæ, but hardly so much so as ordinarily seen in *R. tichorhinus*, and the enamel is not so thick. Both the anterior and posterior barrels are very much compressed at the apex, as shown in the drawing, and the crochet is also much compressed, and given off forwards at a very open angle with the crown of the posterior barrel. The direction of the crochet deviates but little from a straight line; but the crochet does not join on to the anterior barrel as in *R. tichorhinus*, a point of great

[1] Left, not right, as identified by Gastaldi.

Fig 1

p m 2

p m 3

p m 4

m 1

m 2

m 3

Fig 2

Fig 3

[illegible] lith

W West imp

Rhinoceros leptorhinus (Cuv) R megarhinus (Christol)
(1, Imola, 2, 3 Lyons)

importance. The termination of the middle valley is angular (as in the sketch) and there is a very pronounced combing process, emitted from the outer side, and projected across so as to terminate not far from the end of the crochet. The projection of this plate is much more considerable than is shown in the drawing, and agrees very much with that of *R. megarhinus* in Jourdan's big drawing (Pl. XXXII. fig. 2), with the allowance for the latter being more advanced in wear. The posterior valley is very deep, down to the very bottom of the crown. It is large and lined with a very thick coat of cement. The general contour of the crown of the tooth is not prismatic, as in *R. tichorhinus*. The opposite sides (inner and outer) converge towards each other quite as much as in *R. hemitœchus* or *R. megarhinus*, but the crochet forms a much larger plate than in the latter. The anterior outer vertical groove is very angular and pronounced, forming a well-marked narrow step, where seen in the section. No basilar mammilla on the inside between the barrels. The posterior barrel is narrowed inside, into a kind of oblique vertical keel, not round and bulging as in the drawing. Besides the large combing process, the posterior termination of the transverse valley throws up from below a pillar, which is not laterally attached. It is represented by the posterior vallicular mammilla in the figure. The anterior bourrelet is very pronounced and *gaping*, *i.e.* the interspace is well marked.

The most peculiar character probably consists in the form of the 'barrels.' The posterior barrel is constricted about half way up.

Dimensions.—Length of outer surface, 2·3 in. Length at middle along crochet to outer edge of posterior valley, 2· in. Length, inner side, near base, 1·6 in. Greatest transverse diameter at base, 2·5 in. Greatest transverse diameter near top where broken, 1·4 in. Greatest transverse diameter of posterior division (base), 1·9 in. Greatest transverse diameter of ditto at top, ·8 in. The two last measurements show the amount of convergence.

[In Dr. Falconer's Note-book a description is given of two other molars of Rhinoceros in the Nice Museum:—No. 39, a third premolar, and No. 40, a fragment of the first true molar, left side. Respecting the latter it is stated 'there is no indication that the crochet was joined on to the anterior barrel, so as to form during wear a third pit or well, as in *R. tichorhinus*. This confirms the indication of the sixth molar described above. Further, there is not a vestige of a basal bourrelet, although the barrels are not ground so low down as to have caused its disappearance.'—Ed.]

V.—Description of Remains of R. Leptorhinus in the Museum at Rome.

April and May, 1859.

A. *In Professor Ponzi's Collection from the Gravel Beds of Ponte Molle.*

The Rhinoceros remains are much rarer than those of Elephant. The only specimens are:—

1. Two last true molars, upper jaw, left side. (Plate XXXII. fig. 6.)
2. A penultimate upper premolar, left side, much worn.
3. A finely preserved left upper milk molar. (Plate XXXII. fig. 7.)

4. A fragment of a left lower jaw with the penultimate and antepenultimate true molars.

Of the last true molars, the best preserved, A, (Pl. XXXII. fig. 6), resembles very much in form, size, and amount of wear, the specimen of *R. megarhinus*, which I got from Gervais, from the marine sands of Montpellier. It is deficient only at the outer angle, where the grooved portion is broken off by a fracture sloping from the inside outwards. The crown presents the characteristic V-shaped outline. The posterior barrel is somewhat compressed, and at the posterior inner angle (where the rudimentary valley of *R. hemitœchus* is seen), there is a broad adpressed basal tubercle with an obscurely crenated edge, very considerably larger than the tubercle on the Montpellier cast (Pl. XXXI. fig. 2). This tubercle leaves a neck between it and the enamel of the crown, filled up with cement; but there is nothing resembling the *pit* in *R. hemitœchus*; and there is no decurrent groove ascending from it. The principal differences between it and the Montpellier specimen are: 1st, that the valley is more open, with a wider fissure, from more advanced wear, and that there are no remains of the crochet process intruding into the valley (only a sinuous line), nor of a combing plate from the outer angle causing the 'duck's head' pattern of the Montpellier crown, which is seen also in Gervais' drawings. The termination of the valley forms a large oval fossa, which contracts into the fissure, that opens between the barrels. 2nd, that there is a basal tubercle between the barrels, appended to the posterior barrel. 3rd, that there is a well-marked layer of cement, which is abundant in the valley near the intercolumnar tubercle.

The second specimen, B, is nearly in the same stage of wear, but it is mutilated by a fracture, which has removed a portion of the inner side of the last barrel, while the outer angle, mutilated in A., is entire. It corresponds very exactly in form with the other. The posterior barrel shows the same kind of tubercle, adpressed and near the base, but the greater part of it is removed by the fracture. The transverse valley is more contracted in consequence of part of the crochet remaining. The termination is triangular, and a good deal like *Gervais'* fig. 6,[1] but is more triangular and has less of the 'duck's bill' pattern. This specimen very fortunately presents the outer angle entire. It resembles the Montpellier cast exactly in form, *i.e.* it is broad and salient, with a well pronounced vertical groove, and the lobes of the emargination subequal, being very different in form from the *R. hemitœchus* molar; where the angle is narrow, the groove shallow, the lobes unequal, the anterior being much the higher. There is no intercolumnar tubercle in B., but the barrel is broken at that point.

From the annexed comparative measurements, I am satisfied that these Roman specimens, including Lyell's *Ponte Molle* specimen, are of the same species, as the Montpellier one, *i.e. R. megarhinus* of Christol. Lyell's specimen shows much cement at the mouth of the valley, but the outer angle of the chevron is mutilated and rolled, and the posterior barrel is rolled below where the posterior basal tubercle is placed. The enamel in all is thin and smooth.

[1] Paléontologie Française, Pl. ii.—[Ed.]

Comparative Dimensions.

	Cast of Mont-pellier specimen	Ponte Molle, Lyell's *	Ponzi's, No. A.	Ponzi's, No. B.
	In.	In.	In.	In.
Antero-posterior diameter of barrels, inner side, at base	2·15	2·1	2·1	2·
Transverse ditto from base, outer angle, to anterior border	2·4	2·1	2·3	2·2
From ditto to posterior barrel ? .	2·3	2·6 (adding enamel)	2·6	2·3 nearly, but broken
Width of outer angle at apex . .	·65	broken	broken	·6 nearly

* Lyell's specimen partly mutilated.

The next specimen is a third upper premolar, left side, the crown worn very low down, so that the basal bourrelet is removed. The posterior valley is reduced to a '*round* pit,' and the central valley to an isolated fissure, somewhat uniform in outline.

Dimensions.—Width of crown, 1 8 in. Length outer side, 1·45 in. Length inner ditto, 1·2 in.

N.B. In general form this specimen resembles a good deal (fig 1 of Pl. LI.[1]) of the 'Ossemens Fossiles,' which is of the opposite side. In the latter, which is of *R. tichorhinus*, and much worn, the posterior fossette is much larger in proportion to the transverse fossette, and is less round.

The milk molar (Pl. XXXII. fig. 7) is in the finest state of preservation; it has no fangs; the crown is in the best stage of wear to show all the characters. The angle formed by the crochet is very open, in consequence of the obliquity of the disc of the posterior barrel; there is no basal bourrelet, but a rudimentary intercolumnar tubercle. The groove of the external angle is deeply marked and broad, and the posterior niche is also broad and well marked, overlapping the next tooth. The crochet is undivided, and the outer ridge throws off a large solitary combing plate, which is directed parallel to the anterior end of the crown, and at right angles to the crochet, which it nearly touches. The barrels are as fully developed as in a true molar, and but for the small size the tooth would be fixed to be a fourth or last milk molar. The outer vertical groove is very deep, and its posterior bounding ridge very high and strongly developed. The posterior valley forms a gaping triangular fissure, with shelving sides. It is of large size, the posterior edge intact, and emarginate, so as to form a bi-lobed edge like the carnassier tooth of a tiger. The transverse valley is very open at its mouth, forming a triangular fissure. It is then bent gently forwards, to terminate in the *cul de sac*. There is a small intercolumnar tubercle, but not a trace of a basal bourrelet inside. The thick 'combing plate' is almost in contact with the point of the crochet. If they had run together a third fossette would have been formed, as in the premolar. The opening of the transverse valley is gaping, and the posterior barrel

[1] Pl. xiii. fig. 1 of *Rhin.* 3rd edit.?—[Ed.]

is compressed with the peculiar torsion of *R. megarhinus*. It is deeply grooved at the anterior side. The disc of wear points diagonally backwards. (This specimen was named *R. leptorhinus* by Prof. Owen.)

Dimensions.—Length of crown, outer surface near top, 1·8 in. Length of ditto in middle, 1·55 in. Length of ditto, inner side near base of barrels, 1·1 in. Length of outer surface near base, 1·5 in. Transverse diam. anter. end, 1·7 in. Transverse diam. posterior end, 1·6 in.

The lower jaw specimen is a mutilated fragment of the alveolar portion of the left ramus broken off at one-third of its height. It comprises the antepenultimate and penultimate true molar in place, and the anterior half of the socket of the last true molar behind. The antepenultimate is worn in front down to the line of commencement of the outer anterior oblique bourrelet, and has the discs confluent, but the posterior crescent is not much worn, less so than in the penultimate of the Montpellier cast. The anterior end bears a disc of pressure. The penultimate has the apices in the first stage of wear; the disc of the posterior crescent is distinct from, and at a lower level than, the anterior. The posterior end bears a well-marked pressure surface.

Dimensions.

	Montpellier Cast		Roman Specimens	
	Antepenult.	Penult.	Antepenlt.	Penult.
Length of crown at top	1·7	1·85	1·9	2·
Width in front	1·05	1·1	1·4	1·45
Greatest ditto behind	1·2	1.15	1·45	1·5
United length of the two crowns .	3·5		4·	

Compared with the *R. megarhinus* cast, they agree in form and proportions, but are much smaller. They have each the same oblique bourrelet ridge to each barrel (one in front of the tooth, the other behind) on the outer surface. There is a very thick coat of cement below. They differ entirely from the square form and thick enamel of *R. tichorhinus*, with two detached molars of which from Kent's Hole I compared them. I was not able to extend the comparison to *R. hemitœchus*, but I believe them to be of *R. megarhinus*. The specimen is from Ponte Molle (Professor Ponzi's 'volcanic sand').

B. *In the Sapienza Museum, from Monte Sacro.*

Examined a very fine penultimate true molar, upper jaw, left side (No. 111) of a fossil Rhinoceros from Monte Sacro, showing all the characters in the best condition of wear; both the collines and crochet are worn, but the posterior edge of the hind valley is intact (Pl. XXXII. fig. 4). The tooth is of very large size, larger than the detached tooth of *R. hemitœchus*, with which it was compared.

Dimensions.

	Roman Inches	R. hemitœchus Inches
Extreme length of crown, outer surface	2·5	2·35
Ditto, inner side	1·85	2·
Transverse diameter in front, at base of enamel . .	2·7	2·35
Ditto ditto, behind	2·2	2·
Height of crown anteriorly, outer surface . . .	2·2	1·7
Ditto ditto, inner	1·3	0·9

From these dimensions it is seen to be larger than the *R. hemitœchus* tooth, and less advanced in wear. In this respect it closely resembles De Christol's figure of *R. megarhinus*.

Compared with *R. hemitœchus* there are the following differences:—The crochet forms a very open angle with the posterior colline; it is longer and narrows towards the point. The termination of the valley throws out from the outer ridge a thick combing plate, which is directed at right angles to the crochet, and divides the *cul de sac* into two compartments, as in the milk molar in Ponzi's collection. The posterior colline is directed backwards, and has the peculiar torsion shown in De Christol's figure. Further, the anterior overlapping sinus is much more pronounced, and the anterior outer vertical groove is wider and deeper. The enamel is smooth, with some cement on the outer side, but the greater part is removed. There are some denticles in the bottom of the valley, but these have been broken in picking out the matrix of gravel.

This tooth agrees in every respect with *R. megarhinus*, and proves that species to exist in Italy. It has no inside bourrelet, nor intercolumnar tubercle.

There is another specimen (No. 112) also from Monte Sacro, in the Mineralogical Gallery of the Museum, of the last successional premolar, left side, beautifully preserved (Pl. XXXII. fig. 5), and very little worn (like No. 111). It shows a double crochet plate projected in front and downwards, as in De Christol's drawing (fig. 25[1]), but is perfectly free from the combing plate of the outer ridge shown in that figure. It is very nearly in the same stage of wear, and has plenty of cement on the outer surface; the crown is high. There is a well-marked basal bourrelet on the inner side, proving it to be a premolar, and a layer of cement above the bourrelet. The second and lower crochet plate is much smaller than the upper; the two are very unequal, and it is also much less worn. There is very little obliquity in the disc of the posterior barrel, which is parallel to the front barrel; the posterior valley is very large. Ponzi's worn specimen is proved by this to be the third.

Dimensions.—Length of crown, outer side, 1·75 in. Length of crown, inner side, at base, 1·55 in. Length of ditto at middle, 1·55 in. Transverse diameter at base anteriorly, 2·2 in. Transverse ditto posteriorly, 2·15 in.

Lastly, No. 113, also from Monte Sacro, is a first true molar, upper jaw, left side. The crown is nearly in the same stage of wear as Ponzi's milk molar (Pl. XXXII. fig. 7), but is a good deal rolled. The posterior colline is broken off.

[1] Reproduced in Pl. xviii. fig. 1 of this work. See *antea*, p. 328, *note*.—[Ed.]

C. *In Signor Ceselli's Collections, from Torre di Quinto and Ponte Mammolo.*

In Signor Ceselli's collections from Torre di Quinto there is an antepenultimate true molar, right side, of Rhinoceros. It is in nearly the same stage of wear as the penultimate in the Sapienza Museum (p. 374), though of the opposite side, and is very much smaller in all the dimensions, but the height of the crown proves it not to be a milk molar. The crochet forms a very open angle, and a combing plate is emitted from the middle of the outer ridge converging a little towards the point of the crochet. There is also a short combing process emitted from the anterior colline overlapping the tip of the crochet, and a little above it. Further, deep down in the valley, are additional denticular complications, forming a ring or a loop, one leg joined to the outer ridge, one to the outer colline: very complex.

The disc of the posterior colline is directed backwards, with torsion of the apex. There is a small intercolumnar tubercle and a good deal of cement. In all the characters the tooth agrees with the Montpellier *R. megarhinus*, and in general plan it is very like the drawing of the milk molar.

Dimensions.—Extreme length of crown, outer side, 2·2 in. Extreme ditto, inner side, near base, 1·5 in. Transverse diameter in front near base, 2·1 in. Transverse ditto behind, at enamel edge below (very oblique), 2·1 in. Greatest height, outer surface, 2·1 in.

The specimen is encrusted below with volcanic gravel. It has no fangs, and is rolled below. There is some cement at the mouth of the transverse valley, and an abundant layer of it on the posterior valley lining the surface.

Signor Ceselli's collection (from Ponte Mammolo) also contains a very perfectly preserved second premolar, upper jaw, right side, of Rhinoceros, slightly worn (*i.e.* a little less than the milk molar of Ponzi, Pl. XXXII. fig. 7), and in the best state to show its characters. The summit of the crown shows distinctly three fossettes, *i.e.* one formed by the anterior transverse valley, one by the posterior valley, and the third an oval pit included between the termination of the crochet and the combing plate, emitted from the middle of the outer ridge nearly in front of the dorsal vertical ridge. The two are fused into a confluent wall, of which the combing plate is the thickest. The posterior valley has intruded into it, from the posterior outer vertical groove (which resembles in form that of a horse), a very thick blunt plate dividing the end of the valley into two branches. The termination of the anterior valley (exclusive of the third fossette) is somewhat reniform, concavely parallel to the posterior end, and free from any minor plates. The anterior disc forms a narrow strip, little worn; the posterior disc is nearly the same, and has not much obliquity. There is no torsion, no posterior colline at the apex, and no intercolumnar mammilla, but a well-marked basal bourrelet to the inner side. The outer surface resembles the molar of a horse.

Dimensions.—Length of crown, outside, 1·45 in. Length of ditto, inner side, at basal bourrelet, 1·1 in. Length of ditto, in middle, to ditto, 1·35 in. Transverse ditto, in front, base, 1·6 in. Transverse ditto, behind, 1·6 in. Height of crown, outside, 1·7 in.

The specimen has volcanic sand matrix, and is rolled below; the fangs are entirely gone. There is no cement remaining. The enamel is smooth. It is from Ponte Mammolo (Monte Sacro).

In the same collection from Torre di Quinto there is also a penultimate, or antepenultimate true molar upper jaw, left side, considerably more advanced in wear than the others, and differing in some degree from them in the general form of the crown (Pl. XXXII. fig. 8). It is more advanced in wear even than the detached *R. hemitœchus* tooth brought for comparison, and the worn summit is much flatter than any of the others, except Ceselli's very old compressed tooth. The general contour of the crown is more square, and with less inequality between the front and posterior diameters, approaching somewhat in this respect *R. hemitœchus*. There are two valleys, the posterior of which is triangular and ground low, and the inner slopes in a more shelving manner than in *R. hemitœchus*. The middle valley opens into a triangular fissure; it is then bent nearly at right angles, by the intrusion of the crochet, and terminates in a complex *cul de sac*, which is three-lobed, or trefoil-shaped. The termination of the middle valley is not unlike a more advanced degree of the large penultimate in Pl. XXXII. fig. 4. A thick short plate is projected backwards from the anterior colline overlapping the direction of the crochet, and pointing parallel to it from the opposite side; the ordinary combing plate from the outer ridge is projected inwards at right angles to the apex of the crochet, but more as a deep-seated denticle, the apex of which is still partly free. The crochet makes the third division. The crochet differs very much in direction from the other specimens. It is thrown forwards at a *right angle*, but with none of the boot-shaped thickening of *R. hemitœchus*. The length of its inner border is fully equal to the width of the posterior colline disc. There is a small intercolumnar tubercle at the mouth of the valley. The anterior colline presents a sausage-shaped broad disc; the posterior barrel has somewhat of a horse-shoe pattern (from the posterior valley), but the disc is very wide. The anterior outer vertical groove is wide and deep; but the outer edge of the crown is less angular in its outline than usual, the points having been probably abraded by rolling. The anterior overlapping sinus is much more pronounced than in *R. hemitœchus*.

The crown differs in its general pattern a good deal from the others. The crochet is at right angles, but it is not the crochet of *R. hemitœchus*. It certainly is not of *R. tichorhinus*. On the whole, I regard it as an unusual form of *R. megarhinus*. The greater width at the inner side and the abrasion of the outer edge give the peculiar appearance.

Dimensions.—Length of crown (antero-post.), outside, 2 25 in. Length of ditto in middle, 2 1 in. Length of ditto at inner side, about 1 95 in.

The fangs are wanting and replaced by volcanic sand matrix. The fangs had been rolled. The enamel is smooth and rather thin; the cement is entirely gone.

In the next place there is an antepenultimate (penult.?) true molar, upper jaw, right side, very far advanced in wear, of large proportional size, but very much compressed (Pl. XXXII. fig. 9). It retains the fangs, perfect to their points. An oblique fracture (at *a*) has damaged a small portion of the posterior barrel, and another recent (at *b*) has removed the anterior outer angle and the layer of enamel. The surface of the ivory here shows some very beautiful bluish black dendritic crystallization penetrating into the ivory. The crown is oblong across (the disproportional width to length being much more than is shown in the figure), and

is ground down very low. There are two fossettes; that of the posterior valley is a small round hole. The transverse valley is a very contracted fissure at the commencement, terminating in a 'duck's head' kind of *cul de sac*. The crochet is short and thick, and given off at a very open angle; at the ends and inner side of the tooth there is a very thick layer of cement. The crown in amount of wear and pattern (except in the direction of the combing plate) is not unlike the antepenultimate *R. hemitœchus* (m. 1), in Dinkel's drawing with the six molars. (See Plate XVI. fig. 1.)

Dimensions.—Greatest width of crown near ant. fract. at top, 2· in. Greatest ditto behind, at posterior barrel, 1·7 in. Greatest ditto of crown at base, front, 2·5 in. Greatest ditto behind, 2·5 in. Antero-posterior diameter of crown at top, outer, 1·8 in. Antero-posterior diameter of crown at top, inner, 1·6 in. Antero-posterior diameter of crown in middle, 1·7 in. Antero-posterior diameter of crown, greatest, 1·8 in.

The enamel is smooth, the cement is thick, and there is volcanic sand below.

Lastly, in Signor Ceselli's collection, from Torre di Quinto, there is a detached penultimate right molar, lower jaw, having a disc of pressure in front and behind. It agrees exactly in form with the penultimate described of Ponzi's jaw fragment (p. 374), but is a trifle larger. It is nearly in same stage of wear.

Dimensions.—Extreme length, 2·1 in. Width of front barrel, 1· in. Width of rear barrel, 1·2 in.

It has a very thick coat of cement between the barrels, which has been rubbed off elsewhere; this is as thick as in *R. hemitœchus*. The enamel is smooth, but rather thick. The fangs are present.

In Signor Ceselli's collection from Ponte Molle there is also a third premolar, lower jaw, right side, well worn.

Dimensions.—Length of crown, 1·1 in. Width in front, 0·9 in. Width behind, 1·1 in.

D. *In the Museum of the Jesuits' 'Collegio Romano.'*

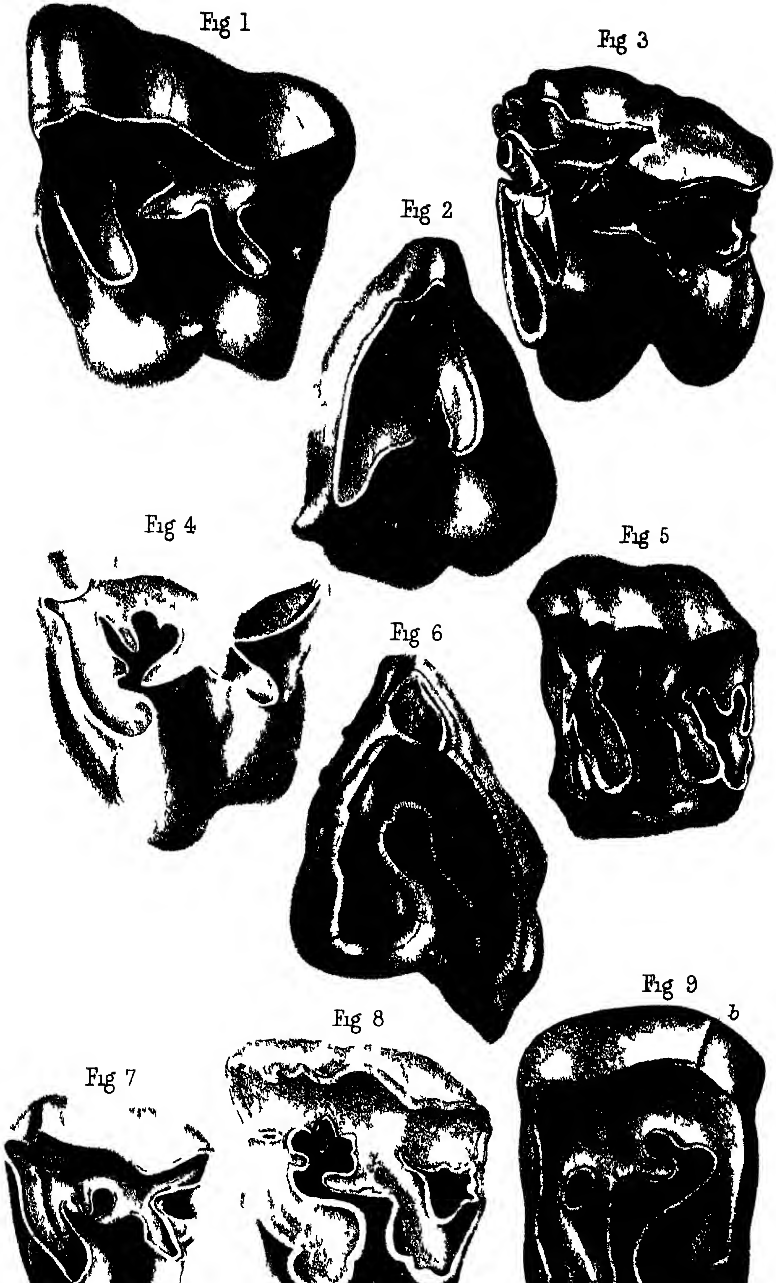
Examined a very remarkable fragment of the transverse half posterior portion of a last true molar, upper jaw, left side, of a Rhinoceros, in different mineral condition from all the other Roman specimens. It shows a tubercle with four crenatures, attached to the base as in the Montpellier specimen, and the addition to the valley of a combing plate, thick, and pointing at right angles to the crochet; there is also a very distinct intercolumnar tubercle. The disc of the compressed posterior barrel is very well preserved. The enamel is of a bluish grey or lead colour, thin and smooth; there is some cement outside. The ivory is chestnut-coloured, like the Pignano Elephant ivory;[1] the matrix is seen to be a blue clay. The specimen is certainly not from the quaternary volcanic sands of Rome; its origin is not known.

The tooth is very much smaller than Ponzi's last molars.

Dimensions.	Inches	In Ponzi's A. (p. 372) Inches
Transverse diameter near base	2·2	2·6

But for the small size, I would have referred this specimen to *R. megarhinus*, notwithstanding the combing plate, in consequence of resemblance of general form, the exact resemblance of the adpressed basal

[1] See *antea*, p. 187.—[ED.]



J Dinkel lith. W West imp

Rhinoceros leptorhinus (R megarhinus)

tubercle behind, and the form of the crochet (open angle), together with that of the disc of the posterior barrel and the width and broad deep furrow of the outer angle.

The upper molars of *R. leptorhinus*, which I have examined at Rome, are: 3 of t.m. 3; 1 of t.m. 2; 4 of t.m. 1; 1 of p.m. 4; 1 of p.m. 3; 1 of p.m. 2; and 1 of m.m.

I have not seen a trace of an indigenous tooth of *R. tichorhinus* in any of the Roman collections. The teeth in the Kircher Museum are evidently of foreign origin. They consist of one upper molar and of two lower molars, all detached and worn, with the yellow ochre matrix of the Devon and Somerset caves.

VI.—Note on R. Leptorhinus from Montignoso, near Leghorn.

Florence, May 20, 1859.

No. 1.—Is a fragment of the anterior part of the right maxillary, showing the antepenultimate and penultimate premolars much worn. Compared them with Jourdan's casts and drawings from Montpellier (p. 369), and found them to agree exactly.

No. 2.—Is a penultimate or antepenultimate true molar, upper jaw, left side, exactly like the Montpellier specimens.

No. 3.—Consists of a penultimate and antepenultimate of upper jaw, right side, detached and well worn, agreeing closely in form with the Montpellier specimens. In the penultimate, a very thick layer of cement lines the posterior valley and both the outer anterior angles; the groove is broad and deep.

No. 4.—Is a specimen of the last premolar, upper jaw, right side, in beautiful preservation and showing the characters very perfectly. The posterior barrel throws forward two crochet processes nearly of the same size, of considerable thickness, and well separated; the outer ridge throws off converging 'combing plates,' nearly of the same size, so that the sinuosities of the transverse valley are very complicated.

No. 5.—Is a fragment of the lower jaw, left side, containing the penultimate true molar, partly worn, but having the crescents still separated.

These specimens are of great interest in proving the extension of the *Rhinoceros megarhinus* into the '*Val d'Arno inferiore.*' They were found along with remains of *Elephas antiquus.*

VII.—Note on Rhinoceros from Val di Chiana.

Arezzo, May, 1859.

Examined a lower jaw, right side, of Rhinoceros in the same mineral condition (*i.e.* white and adhering to the tongue), as the large Elephant femur and bovine heads from the Val di Chiana in the Florence Museum. Only part of the symphysis is present. The anterior margin of the right ascending ramus is present, but the posterior angle is wanting. The jaw contains the five last molars *in situ.* The antepenultimate premolar has dropped out, but its two fangs are seen. The molars are well worn; the crown of the first true molar is worn out; and in the last the discs of the crescents are united. The teeth show marks of a thick layer of cement dislaminated; there is an oblique bourrelet on the outside of the barrels as in *R. megarhinus.* The enamel is thickish and

smooth. It certainly does not belong to *R. tichorhinus*, and the teeth are too large and too broad for the Rhinoceros of the Val d'Arno. It is probably, *R. megarhinus*, and is an important specimen. The lower jaw is very low for the thickness and size of the teeth.

Dimensions.—Length of line of six molars, 9·5 in. Length of crowns of the five, 8·1 in. Length of three last molars, 5·6 in. Approximate length of three premolars, 4· in. Length of two last premolars, 2·5 in. Length of crown of penultimate true molar, 1·85 in. Greatest width of ditto, 1·2 in. Length of last molar, 2·1 in. Total length of fragment, 14·5 in. Height of jaw inside at penultimate premolar, 2·5 in. Height of ditto at last molar, 3·8 in. Greatest thickness of jaw below, 2·1 in.

Another specimen of left side of lower jaw is very like the above, but all the teeth are wanting.

VIII.—Description of Remains of R. Leptorhinus in Museum of Nat. History at Turin.

April, 1861.

A very beautiful specimen of a right ramus of the lower jaw of a fossil Rhinoceros, marked 'Foss. nei sedimenti fluvio-lacustri pliocenici tra Dusino e S. Paolo (dono dell' Ingegnere Commend. Barbavara),' in a hard mineral condition, weathered grey, containing the whole of the molar series *en suite*, and part of the symphysis, but the diastemal edge entirely gone; the horizontal ramus quite entire from the first premolar backwards, but the angle broken off; part of the anterior and basal portion of the ascending ramus present, but the fracture rounded by abrasion.

The teeth in form, and amount of wear relatively, is nearly a perfect reproduction of Gervais' Montpellier lower jaw (Pl. II. fig. 8 of 'Zoolog. Française'), from the first to the last, so much so that the one might be taken for the other. But unfortunately, the Turin specimen wants all the incisive and diastemal portion. The horizontal ramus is very low, as compared with the double lower jaw got in the Mastodon deposit. The posterior boundary of the symphysis is in a line with the posterior third of the penultimate premolar. The lower edge of the ramus is very horizontal from behind on to the premolars.

The characters of the molars in this specimen are a good deal as in Mr. Gunn's lower jaw. One character of great importance is to be noticed, that on the outside of the penultimate molar, in the furrow between the crescents, there is a very thick layer of cement; it is only partially present, and probably is dislaminated elsewhere.

Dimensions.—Length of six molars, 9·5 in. Length of three true molars, 5·4 in. Length of three premolars, 4·1 in. Length of first premolar, 1·2 in. Length of second ditto, 1·3 in. Length of last ditto, 1·5 in. Length of antepenultimate true molar (middle of crown), 1·6 in. Length of penultimate ditto, 1·7 in. Length of last ditto, 1·95 in. Greatest height of jaw to alveolar edge of last molar, inner side, 3·3 in. Height of ditto at first true molar, 2·75 in. Greatest height at antepenultimate premolar, 2·4 in. Greatest thickness of jaw, 1·85 in. Height behind last molar, inner side, 3·4 in.

In the same Museum there is also a penultimate or antepenultimate true molar, upper jaw, left side, of *Rhinoceros leptorhinus* (*megarhinus*). The anterior outer angle is a little broken, but the crochet has the same character as in the Grays Thurrock variety. It is certainly not *R.*

Etruscus. But the matrix is exactly like the Sansino of the Val d'Arno. It is from the railway cutting near Dusino.

There are also two upper premolars showing the bourrelet very strong, but the crown still covered with matrix, of the same species and from the same locality, with a yellowish ferruginous matrix.

IX.—Description of the Cortesi Rhinoceros Cranium.[1]

Natural History Museum, Milan, April 24, 1861.

The cranium, upon the whole, is in a very remarkable state of preservation, and is now very much in the condition as described by Cortesi in the 'Saggi Geologici.' It is entire, from the tips of the nasal bones to the occiput; the left side of the occipital crest being the part chiefly damaged. The skull, like Jourdan's Lyons Museum Cranium (Pl. XXXI. fig. 3), had undergone lateral pressure, so as to have been slightly crushed. This is well shown on the basal aspect; when an axial line is drawn along the base of the sphenoid through the palate, the palatal portion is seen to be deflected towards the right side; and the spheno-palatine bones are crushed. The whole of the right zygomatic arch is present, but partly crushed in upon the zygomatic fossa. The crush has acted upon the palate, so as to elevate considerably the series of molars upon the left side, above the plane of those of the right; the former being pressed a little outwards, the latter inwards, upon the plane of the palate. The left zygomatic arch is partly wanting, but the basal portions at either end are present, and the posterior stump shows that a portion at least has been lost by a comparatively recent fracture (since found). The mastoid process on the left side is broken off, while the greater portion of the styliform process behind it is present; *vice versâ*, on the right side the greater portion of the mastoid process is present, while the styliform is broken off. The two (occipital) condyles are present, and nearly undisturbed, although somewhat damaged; the occipital part of the cranium has fortunately escaped pressure; the lateral margins and crest on the left side are nearly entire; the upper third of the right side is broken off. The right occipital condyle is traversed by two fissures; the left has lost a portion towards the occipital plane. On making a further search among the fragments in the case, I found the missing portion of the left mastoid, which is now seen perfectly entire, and probably a further search would lead to the discovery of some portion of the missing part of the left zygomatic arch. I found the specimen taken off its stand, and laid upon a pad of straw with the palatine surface uppermost, preparatory to being drawn. Seen in this aspect, it bears a very close and remarkable general resemblance to Jourdan's Lyons skull (Pl. XXXI. fig. 3, p. 369), which is also somewhat crushed, but in the reverse direction (*i.e.* according to the lithograph), viz. from right to left (Cortesi's skull being from left to right). The occipital condyles in the Lyons cranium are obliquely displaced, while in Cortesi's skull they are in their natural position. The bony part of the cranium is a good deal cracked and shivered, so as to break off into minute pieces when the matrix is detached; but it is highly injected with ferruginous infiltration, and completely mineralized. The matrix consists of a greyish yellow compact clay (marna azzurra), which is hard and mottled with ferruginous

[1] Dr. Falconer was unfortunately not permitted to take any drawings or casts of this cranium.—[Ed.]

blotches. A portion of the diastemal and incisive prolongation, which is wanting in the Lyons skull, is fortunately present in the Milan specimen. The series of molars is present on both sides, but the summits of most of the crowns are more or less involved or concealed by matrix, which has been left very nearly as when found by Cortesi. The following teeth are present or indicated:—

A. *Right Side.*—1. Immediately behind the commencement of the diasteme, on the right side, the empty socket is distinctly marked of a single-fanged premolar, being the normal pre-antepenultimate (p.m. 1). The alveolus is oval in the transverse direction, and about eight lines in diameter. I have picked some of the matrix out of it, so as clearly to define the pit, and am quite certain of the accuracy of the observation. The corresponding socket of the same tooth is present on the left side, but has not been picked out to the same extent.

2. *The antepenultimate premolar or* (*p.m.* 2).—The shell of the crown of this tooth has been broken off, but it is fortunately preserved on the left side, and will be noticed in the sequel.

3. *The penultimate premolar or* (*p.m.* 3)—The shell of enamel nearly all round the circumference of this tooth is preserved, but the central convolutions and the anterior inner barrel have been ground down and destroyed by a recent crush. The salient point of the outer shell of enamel is very high, and it almost looks at the posterior point as if it had not been subjected to wear; but this is very doubtful, there being no ivory attached to determine the point. The corresponding tooth of the opposite side is present nearly entire; but the outer half of the crown is covered by matrix which conceals the convolutions.

4. *The last premolar* (*p.m.* 4) is present, and beautifully perfect. It had evidently come but very lately into place, as the edges only of the anterior and posterior barrels are slightly worn into narrow crescentic discs, and the outer edge is also but slightly affected by wear. The level of the crown is depressed below the level of both the tooth which precedes it, and of that which is behind it; it is in a considerably less advanced state of wear than the next succeeding teeth (*i.e.* t.m. 1 and t.m. 2), and therefore had come into place more recently than either of them. The basal bourrelet is distinctly marked at the anterior and posterior ends, but only very obscurely around the base of the inner side, as a slightly crenulated inequality. The anterior and posterior barrel ridges are nearly transverse and parallel, the posterior fossette is very large and intact behind. The crochet plates are very complex, forming four pectinate laminæ, which are directed forwards so as to meet an accessory plate thrown off inwards from the outer ridge, which divides the central termination of the middle valley into two nearly equal divisions. In this respect, the tooth resembles very closely fig. 25 of De Christol's plate (see Pl. XVIII. fig. 1), but with this difference, that the crochet plates in the latter are only two, while in the Milan tooth they are closely approximated and are four in number. But De Christol's tooth is more advanced in wear, and the crochet plates would be reduced in number in the Milan tooth by further abrasion. One of these plates advances so as nearly to meet the accessory outer combing plate, and thus isolate a distinct fossette. There is a contortion of the apex of the posterior barrel (as in Pl. XVIII. fig. 1).

On the opposite side the corresponding tooth is apparently wanting, its place being occupied by matrix. This would indicate either that

the last premolar, left side, had never emerged, or that it had dropped out after emergence. (On subsequently removing the outer alveolar wall it was visible.)

The basal bourrelet, as a general rule, is but indistinctly exhibited in all the premolar teeth of this specimen.

5. *The antepenultimate true molar* (*or t.m.* 1).—This tooth is present in a more advanced state of wear than either p.m. 2, 3, or 4, the stage of detrition being about the same as in De Christol's fig. 18 (copied in Pl. XVIII. fig. 3), but even a little more advanced. The crown of the tooth had originally been quite entire in this specimen, but it had got crushed and shivered; the pieces have been replaced in position with glue. The posterior fossette and the whole of the middle valley are enveloped by matrix, so that the offset of the crochet is entirely concealed, as is the greater portion of the inner side of the two barrels. The anterior basal talon bourrelet is very pronounced, with a crenated margin. The corresponding tooth of the opposite side (left) is also present, and still more perfectly conserved; but the crown is nearly entirely enveloped by matrix, so that the characters yielded by the crochet are not visible.

6. *The penultimate* (*or t.m.* 2), *right side*.—This tooth is present and quite perfect, but is pressed slightly inwards upon the palate. The outer shell of enamel is seen to be quite perfect, and the outer ridge but very slightly abraded, the boundary of the posterior fossette being quite entire. The anterior barrel has its edge but slightly abraded, a little more in degree than p.m. 4; the whole of the central valley and of the inner sides of the barrels are enveloped by matrix, so that the form and offset of the crochet and the anterior basal talon are completely concealed. This concealment of the most characteristic part of the crown is much to be regretted for my present purpose. The corresponding tooth of the opposite side is also present, but fractured and repaired; it is slightly dislocated outwards (like the whole of the series of the left side), exposing completely the inner side of both barrels, down to their base. There is not the slightest trace of an internal basal bourrelet, and the summits of the barrels, more especially the hind one, show very markedly the peculiar twist seen in fig. 18 of De Christol's plate (as copied in Pl. XVIII. fig. 3). This character is equally seen on the corresponding parts of p.m. 1, left side.

7. *The last true molar* (*t.m.* 3) of the right side had not emerged, and there is not a trace even of its presence, the corresponding alveolar part of the maxillary bone being crushed in and covered by matrix; but, as will be seen in the sequel, the germ of this tooth is distinctly present on the left side.

B. *Left Side*.—1. *The pre-antepenultimate, or* (*p.m.* 1).—The single-fanged alveolus of the first premolar is present, as in the opposite side, distinctly defined, and partly occupied by matrix.

2. *The antepenultimate, or* (*p.m.* 2).—The crown of this tooth is present, quite perfect, and but very slightly affected by wear. In a general way it resembles very closely fig. 1 of Gervais' Pl. II. ('Paléontologie Française'), with the exception that the basal bourrelet, which is distinctly present upon the anterior barrel, is less pronounced on the posterior barrel than seen in that figure. The crown has a similar sub-triangular form, *i.e.* broad externally, and contracting inwards. The apex of the anterior barrel, which is all but intact, forms an

isolated flattened conical cusp, as in Gervais' fig. 3. Pl. II. of tom. ii. of the 'Memoirs of the Montpellier Academy of Sciences,' but of a larger size than in that figure. The posterior colline is seen to be but slightly abraded by wear; the whole of the posterior fossette and the central crochet convolutions are entirely concealed by matrix. This tooth appears to be nearly in the same stage of abrasion as p.m. 4 of the opposite side.

3. *The penultimate premolar* (*p.m.* 3).—The whole of the shell of this tooth is present, but the outer half of the crown is completely enveloped by matrix. The anterior and posterior barrels are seen to be but slightly abraded, *i.e.* to about the same extent as t.m. 2; the breadth of the tooth across the anterior division is much greater than the length. There is a crenulated anterior talon, but only a very obscure appearance of bourrelet at the base of the anterior barrel; none is visible behind, but this part of the tooth is enveloped by matrix. The vertical furrows upon the outer surface of the enamel of this and the preceding tooth are but very indistinctly marked. The same observation applies to p.m. 4, of the opposite side, in which the anterior vertical furrow is also indistinctly marked.

4. *The last premolar* (*p.m.* 4) on this side, as already remarked, appears entirely wanting, and its position is occupied by a block of matrix; but on reversing the cranium, it is distinctly seen enclosed in its alveolus, below the mass of matrix.

5. *The antepenultimate true molar* (*t.m.* 1).—The crown of this tooth is nearly perfect, although somewhat shivered. The summit is almost entirely enveloped by matrix concealing the crochet and other convolutions. The vertical furrow of the anterior outer angle is broad and shallow, but well pronounced—broader than in De Christol's fig. 18 (see Pl. XVIII. fig. 3). The summits of the barrels are in the same stage of wear as described of the tooth of the opposite side. The outer surface of the posterior division is slightly concave and flattish.

6. *The penultimate true molar* (*t.m.* 2).—This has its crown more exposed than on the opposite side, but it has been fractured, and the pieces have been imperfectly replaced. The peculiar twist of the apices of the barrels has been already noticed. The anterior vertical furrow seen at the outer angle of the tooth of the opposite side is also here well marked.

7. *The last true molar* (*t.m.* 3), on the left side, is distinctly seen in the state of germ, hardly emerged above the alveolar level, and embedded in the jaw. About an inch in height of the posterior ridge is exposed by the removal of the alveolar wall. The edges are quite intact, and about an inch and a half below the level of the next preceding tooth. The principal valley is completely filled up by matrix, but it is visible that the crown had the sub-triangular form, which is characteristic of the same tooth in the existing bi-corned African Rhinoceros.

Obs. 1.—The enamel surface in all these teeth is tinged of a bluish grey, which Cortesi compares to an incipient tint of turquoise. The enamel is perfectly smooth, *i.e.* entirely free from any superficial rugosity, as in the *tichorhine* Rhinoceros, and I could detect upon none of the teeth any indications of a coat of cement. There is certainly nothing approaching the enormous coat of cement seen on the teeth of *Rhinoceros hemitœchus*; the enamel is not so thick as in that species, nor so rugous on the surface. The ivory-core of all the teeth is highly infiltrated with iron, showing a dark amber colour; the general colour of

the teeth resembles in its pearly aspect that of the molars of *Rhinoceros Etruscus*, in the Museum at Florence. It is important to remark in reference to the measurements, that on the right side the penultimate does not overlap the first true molar, there being three-tenths of an inch interval between. There is nearly the same interval between the antepenultimate true molar and the last premolar, and also between the third and fourth premolar, showing that these molars have been displaced, and giving undue length to the measurement of the entire series on the right side. They are in their natural state of apposition on the left side. The length of the series, from the anterior end of the second premolar to the posterior margin of the second true molar, which includes five teeth, amounts exactly to 10·2 inches, and from the anterior border of the first premolar to the same point behind, to 10·9 inches (or nearly 11 inches).

Obs. 2.—Cortesi's figure in the 'Saggi Geologici' (Pl. VII.) is apparently of the left side (the nasals and symphysis pointing to the left, the occiput to the right); but the figure is exhibited reversed, and in reality it represents the right side. The same remark applies to fig. 7, Pl. IX. *Rhin.* of the 'Ossemens Fossiles,' professing to be on the scale of one-sixth of the natural size. The lower jaw, which is placed in relative position below the cranium in both these cited figures, is also figured reversed. Cuvier asserts that his engraving was made after drawings sent by Adolphe Brongniart, and these have hitherto been assumed to have been originals; but it is clearly manifest that Brongniart's is merely a copy of Cortesi's figure. The uncouth lower jaw is foreshortened precisely alike in both, so as to show the line of molars on both sides, both coronoid processes, both sigmoid notches, and both condyles. In fact the figures are so much alike that it is impossible to doubt that the one was copied from the other. There is the same nick to the broken edge of the left coronoid process, and to the broken end of the incisive bone. The principal differences are, that the mastoid shown in Cortesi's figure is omitted by Brongniart; that the rim of the orbit and the outline of the zygomatic arch, together with the shading of the orbital cavity and zygomatic fossa, are better defined by Brongniart than in Cortesi's figure. The uncouth occipital pyramid rising into a conical peak, and evidently exaggerated in Cortesi's figure, is less salient and more naturally represented by Brongniart. As regards the lower jaw, Cortesi's figure represents a salient mass of matrix on the lower margin of the jaw, below the penultimate figured tooth (*i.e.* t.m. 1), all of which is omitted by Brongniart, who gives a clear outline to the lower margin. But this mass is still undisturbed with the rest of the matrix, as when left by Cortesi.

Obs. 3.—De Christol, in his remarks upon Brongniart's figure of the lower jaw, passes some severe strictures upon the low height and little projection of the coronoid process above the alveolar margin, &c. But these are all explained away by the fact that a great deal of matrix is still left enveloping the jaw, and that a part only of the crowns of the two last molars that are *in situ* emerge above the cake of matrix. When the natural object is compared with fig. 5 of De Christol's drawing (profile) it is manifest that there is a great general agreement of form between the Montpellier and Milan specimens, and even an inexperienced observer would at once remark the similarity of the symphysial expansion in both.

Obs. 4.—The antepenultimate premolar (p.m. 2) of the left side in the Cortesi specimen resembles in the closest manner the corresponding tooth represented by De Christol in fig. 27 of his memoir.[1] The anterior cusp forms in both an isolated compressed cone, the apex of which is just beginning to be abraded, and the posterior barrel has its edge ground down into a narrow crescentic band, which is alike in both. The principal difference observed is, that the basal bourrelet is more strongly represented in De Christol's figure than it is seen in Cortesi's.

Obs. 5.—The lower jaw of Cortesi's specimen is seen to be in the most fragile state of disintegration. On detaching a slab of the matrix, measuring 3½ inches by 3 beneath the second and third premolars (p.m. 2 and 3) on the left side, it was seen that the fibrous roots of herbaceous plants had insinuated themselves between the matrix and the surface of the jaw, forming a web, and that the bony mass of the latter was cracked and fissured in every direction, penetrated by roots, and in a state of the most rotten decay. The lower jaw was evidently discovered uncrushed. A great mass of matrix is interposed between the rami from the symphysis on to behind the last molar, yielding the dimensions given in the table (viz. Nos. 17 to 21). The details of the teeth in the lower jaw are as follows:—There is not a trace of incisives, the beak being partly damaged at its edge, where they might be looked for, and the diastemal ridges being also abraded. The lower contour of the beak expansion is disguised by a cake of matrix, which has vitiated both Cortesi's and Brongniart's drawings; otherwise it would be like Christol's fig. 6. There is no trace on either side of an alveolus for the pre-antepenultimate, but it is by no means certain that it may not have been there to correspond with the tooth in the upper jaw. The antepenultimate premolar present upon the left side consists of two crescents, both of which are only in the slightest degree affected by wear. The lower half of the anterior end bears a smooth surface, which appears to be the disc of pressure against a pre-antepenultimate, which had dropped out. This disc of pressure for the pre-antepenultimate of lower jaw, left, occupies nearly half the height of the crown and is sagittate in form, like a Celtic arrowhead of flint. From the broad surface of the anterior end of the antepenultimate, and the appearance of a disc of pressure at its base, I am convinced that there must have been a pre-antepenultimate, corresponding with the upper one. The third premolar is present upon both sides, and both the crescents are slightly affected by wear, showing a narrow band of enamel all round. The anterior crescent in each is elevated about half an inch above the plane of the posterior crescent. The last premolar is wanting on either side, its site being occupied by a mass of matrix; the last milk molars had probably just fallen out, and their successors may be embedded in the jaw as germs. The two stumps of the fangs of the antepenultimate premolar are seen on the right side, the crown being broken off.

The first and second true molars are present on either side, both of them being but slightly affected by wear. The anterior division of each yields a horse-shoe pattern, of which the front limb is much shorter than the hind one. The posterior division yields a crescent with but a very slight curve. The last true molar on either side is wanting.

The condition of the dentition in both the jaw and cranium shows that they must have belonged to the same individual.

[1] Ann. des Sc. Nat. 2me Sér. tom. iv. 1835. Pl. iii. fig. 12. See *antea*, p. 328, *note*.—[ED.]

Obs. 6.—De Christol's drawing, fig. 11, although stated by him to represent the left side, is in reality of the right. The ragged black shaded wall A of his figure represents pretty fairly the existing condition of the left wall of the nasal cavity, inner side; and although mistaken by him for a nasal septum, is exactly what Cornalia states it to be in his note to Duvernoy.[1] The light shaded portion included within dotted lines is not, as De Christol supposed, a fracture where a large piece was wanting, but in reality it represents a layer of argillaceous cement, which has been spread over the fossil from the orbit to the incisive termination, either to strengthen the specimen or to disguise fractures. A depression is left in the cement, indicating the position of the suborbitary foramen. It is exactly situated as in Cortesi's drawing, but the clay envelope deprives me of the means of deciding whether it really is the suborbitary hole or not. The fractured slab of the frontal between the orbits, indicated in Christol's drawing by the letter C is a mistake; the whole plateau of the frontal at this point, although cracked and broken into minute pieces, is entirely present. The angles of the lozenge on either side are broken over the orbits, and the drawing of the fracture on the right side has misled De Christol. On removing the cement, I find that the suborbitary foramen is present on the right side, and situated exactly over the line of junction between the third and fourth premolars; its posterior rim being in a line with the anterior third of the last premolar, and yielding the following dimensions:—From anterior rim of orbit to posterior margin of suborbitary foramen, 4·2 inches; from the same point, *i.e.* rim of orbit to bottom of nasal echancrure, 4·8 inches; from bottom of nasal echancrure to tips of the nasals, 8·4 inches; apparent entire length of nasal bones, measured along curve, from the naso-frontal suture to tips in the middle, 12· inches.

The uncouth representation in profile of the molar teeth in Cortesi's, Cuvier's, and De Christol's figures is owing to the fact already stated, that they are pressed inwards upon the palate, more especially the two last, and their most salient points therefore appear fore-shortened; the representation of the opposite side would be much more natural. The orbit is immediately over the penultimate and last molars, its anterior margin on both sides falling in the line between the antepenultimate and penultimate true molars. The outline of the naso-maxillary sinus is well pronounced, as in Cuvier's figure, and the present height, which is partly concealed, is approximately 4·2 inches, taken about the middle. Strictly speaking, the orbit is situated immediately over the penultimate true molar.

Continuation of Description of the Cranium.

Most of the details in the anterior part of these remarks were taken when the Cortesi cranium was lying with the palate upwards; it has since been turned and mounted on a tripod stand, admitting the profile and upper surface to be compared.

Profile.—This bears, as stated by previous describers, a close general resemblance to that of the Sumatra bicorned Rhinoceros. The skull has been exposed to lateral pressure, which has crushed in the right zygomatic arch and the maxillary wall of the face, in front of the right

[1] See *antea*, p. 314.—[Ed.]

orbit, under the chaffron. The occipital part is not nearly so perfect now as in Cortesi's time, the left side of the occipital crest being broken off, together with the posterior and upper part of the parietals, to an extent of five inches in length by four in width. In consequence, the posterior termination of the sincipital echancrure and the posterior extension of the occipital crest behind the occipital plane are no longer seen. The diploe cells are exposed where the upper plate of the parietal has been removed, giving rise to the tessellated ragged lines of De Christol's figure, but less marked, and not extending so far forward as he shows. The right zygomatic fossa is covered over by a cake of matrix, about a quarter of an inch thick, as high as the fracture of the parietals; the left zygomatic fossa is covered by a thinner cake of the same. The lower three-fourths of the occipital are entire, more especially on the left side, and the lower half on either side, downwards towards the styloid process, is covered by a thick mass of matrix, all the central portion being bare. A great amount of hard matrix covers the whole of the facial portion from the orbit forwards, as far as the anterior third of the nasal arch, concealing entirely and blocking up the left side of the nasal fossa. This is the mass represented by the dark shade (A) in De Christol's figure.

The cranium, as a general character, looks more elongated, more slender, and much less massive than in the *Rhinoceros tichorhinus*; the cerebral portion is less elongated than in the latter, and the lateral edges of the occiput less projected backwards. The anterior slope of the cerebral pyramid makes a very considerable angle with the plane of the frontal, more perhaps than is seen in Cuvier's figure, but considerably less than is shown by Cortesi's, where the pyramid is exaggerated. The posterior face of the occiput inclines a little forwards as it ascends from the occiput upwards, more so even than represented by Cuvier's figure, and is then over-arched by the projecting sides of the occipital crest, which are produced backwards. It differs entirely from the reclined occipital plane seen in *R. tichorhinus*. The bones of the nose are elongated and slender in thickness, rather wide, and not much arched above; they are nearly of uniform width, thinning as they advance forwards. The nasal suture between them is distinctly marked and open; *there is not the slightest indication of a dividing nasal septum*; and I confirm entirely Cornalia's remarks upon this point. They are not so much arched as represented in Cuvier's figure, resembling more the outline given by De Christol. There is a slight central boss along the axis near the tip of the nasals, but I can detect nothing like an indication either upon the nasal or upon the frontals of the granular rugous inequalities which indicate the base of horns; the frontal, it is true, is cracked and fissured, but the nasal surface is entire and smooth. A strip of about an inch wide of matrix has been left near the tip and side of the right nasal bone. The absence of horned rugosities may be owing to the immature age of the animal, which is shown by the teeth and open sutures to have been not quite adult. De Christol describes the vault of the nasal bones below to be excavated in a boat-shaped fashion; nothing of this kind is seen in Cortesi's fossil, but their lower surface is still concealed by matrix. The character of the nasal bones entirely warrants the designation of *leptorhinus*, or thin nasal-boned *Rhinoceros*, given to this species by Cuvier; these bones are infinitely less massive than in the African Rhinoceros or the Indian species.

The zygomatic arches are crushed in on the right side and wanting on the left; the extreme height of the arch behind on the right side is about 2· inches. The characters of the temporal fossæ are not shown, in consequence of the state of the zygomatic arches. The form of the articular or glenoid surface for the lower jaw is also concealed by matrix. The intermaxillary portion does not appear to have been complete even in Cortesi's time; it has now been considerably further damaged by a fracture, and the missing piece has not been found. The diastemal edges, as already described, are prominent and well marked, bounding a gutter which contracts forwards; they are now very much in the state represented by De Christol's fig. 12 of the Montpellier form. The orbits are placed immediately over the sixth tooth or penultimate true molar. The position of the suborbitary foramen has already been described. The auditory foramen is well seen on the left side, but filled up with matrix; it resembles very closely that seen in fig. 12 of De Christol, running upwards in a gutter on the side of the occipital crest. In fact, the lateral and posterior part of the parietals and the lateral outline of the occipital crest towards the base on the left side very closely resemble the same parts in De Christol's figure, with this allowance, that in the latter the occipital condyles are wanting, while in Cortesi's they project boldly backwards. The terminal outline of the molar teeth of the left side resembles very closely, in a general way, that of Gervais' fig. 1 of Pl. II. tom. ii. of the 'Montpellier Transactions.' The height from the edge of the penultimate molar, left side, to the frontal plateau, which is crushed, amounts to about 11½ inches. On the right side the same measurement gives 9·7 inches. Unfortunately the orbital rim is not perfect on either side; it is best seen on the right, but the suborbital tuberosity is wanting.

Upper View.—When the skull is seen from above it presents the same elongated slender character as when seen in profile. This is somewhat exaggerated by the skull having been crushed laterally, and by the intrusion of the right zygomatic. In consequence of the immature age of the animal, there is no indication of the sincipital lateral ridges which define the temporal fossæ, so strongly seen in Gervais' fig. 2 of the Plate above referred to, and also in De Christol's fig. 13. Gervais' figure looks much wider in consequence of the presence of the zygomatic arches. De Christol's fig. 13 shows the nasals more massive proportionally than in Cortesi's fossil. In both of these the frontal plane is elevated between the orbits to sustain the second horn. This part of the skull is cracked, fissured, and depressed in Cortesi's fossil, and the angles of the trapezium over the orbits are broken on both sides. Making allowance for this depression, the profile outline of the Cortesi skull resembles more Gervais' figure than De Christol's, as regards the line of contour of the nasals and frontals. The crush is so considerable that on the right side the height from the upper rim of the orbit to the frontal plateau is only 2·4 inches. The sincipital contraction of the cerebral portion between the temporal fossæ is very much as in De Christol's figure; but the absence of bounding ridges on either side leaves no indication of a defined tablette.

Since the preceding remarks were written, I have been further able to restore the posterior missing portion of the left zygomatic arch and the greater part of the left articular condyle of the lower jaw.

On the whole, the Cortesi cranium is in a wonderful state of preser-

vation, considering the numerous removals which it has undergone. It was first deposited at Piacenza in Cortesi's time, then removed to the Museum of Mines in the Stradone di Santa Teresa. After remaining there many years, it was removed with the other Natural History collections in 1848 to the Palazzo Dugnani, and finally (1849) transferred to its present locale in the Museo Civico, Contrada della Maddalena al Cerchio, near the Piazza Santa Marta, along with the rest of Cortesi's fossil collections, which include the Whale skeletons and the palate (and other bones) of the *Elephas meridionalis* figured in the 'Saggi Geologici.' The skull, when De Christol's figure of it was made by Gené, appears to have been nearly in the same state as it is now.

Cortesi mentions, that along with the skull he found 10 vertebræ, 14 ribs, 2 scapulæ, and the 2 fore legs. On looking over the fragments in the case, parts of most of these remains are to be seen. Of the vertebræ there is an axis, which is entire, with the exception of the spinal portion of the neural arch. There are also 8 other vertebræ; the bones of the fore-legs and the scapulæ are unfortunately very much broken. There are 2 humeri, one of which is in three pieces, that do not admit of being joined. The head of another humerus of very large size is in the same mineral condition as the other. It belongs to the opposite side from that in Cuvier's fig. 9 of Pl. XLI. (Rhin. Pl. III., éd. 3me); but as compared with that it yields the following measurements:—From *b* to *d* as in fig. 9, 7· inches; from *a* to *b* 6·1 inches; from *d* to *a* 6· inches; greatest expansion under the neck, 7·2 inches; transverse diameter of head, 4· inches.

The hooked process below the expansion is present in this specimen, but all the rest of the shaft is broken off. There are some metatarsal and metacarpal bones, but of the radius and ulna and scapulæ there are only fragments, not sufficiently perfect for description. Cortesi mentions having discovered in another place the humerus of a Rhinoceros, covered with oyster-shells growing upon it. One of these humeri, nearly entire (the lower articular head being wanting), is still in the collection, and the transverse expansion, where greatest below the articular head, measures only 5·6 inches. It is evidently of an adult animal, as the epiphyses are united; the bone is impregnated with iron, and in a very different mineral state from the other decomposed humerus above measured, and it yields dimensions which are so much less than that of the other above given, that it probably belonged to a distinct species, and that species *Rhinoceros Etruscus*. But I have no time at present to determine that point accurately. This completes all that I can do about the Cortesi Rhinoceros.

In the same case are seen the remains of the palate of the *Elephas meridionalis*, figured by Cortesi. The teeth are the last true molar of either side; that of the right side is entirely exposed, showing twelve ridges with a talon plate behind, and also a front talon. Of these, the front five ridges are more or less worn; the enamel-plate is thick; the discs wide apart and little undulated, with thick ringed digitations. The tooth measures in extreme length 11 inches, and the greatest width of the crown is 4½ inches. Alongside of it is the fragment of an enormous ivory tusk, somewhat oval in section, the greatest diameter of which yields 9½ inches. In the same case there is a portion of a most enormous sacrum, attached to the last lumbar vertebra. Among the Elephants' teeth, upper and lower, in this case, I could detect no indications of *Ele-*

phas antiquus. There is a large collection of Elephant bones in another compartment, some of them exhibiting enormous dimensions.

Memo.—Cornalia has shown me the posterior fragment of an Elephant's molar, found in the deposit above the lignite of Leffe (Gandino). It consists of the last three ridges of the last true molar, lower jaw, right, together with the talon, of undoubted *Elephas meridionalis.* The ridges are worn, but the talon intact. It is a characteristic example of *E. meridionalis,* with very thick enamel, and thick cylindrical digitations. It is nowise tinted black, and is stated to have been found above the lignite. Another fragment of molar, found at the same place, appeared to me to be of *Elephas antiquus*; it was in the same white untinted condition. Besides these, from the lignite of Leffe itself, Cornalia procured a worn-out fragment of a large lower molar of an Elephant. It is difficult to say what the species is, the enamel-plates being too thick for *E. primigenius,* and too thin for *E. meridionalis.* It is probably either of *E. antiquus* or *E. Armeniacus*; the discs show very little undulation of the enamel-plates, but the crown is especially remarkable in having the discs separated by a longitudinal fissure (filled up with cement) like the singular Elephant's molar from Durdham Down, which I observed in the Museum at Bristol. Besides these, some lower teeth of *Rhinoceros* were found in the lignite; one of these is an entire penultimate true molar, slightly worn, and of the right side, exactly resembling in every respect the corresponding tooth in Cortesi's lower jaw. It is free from cement, and from the surface rugosity, observable upon the enamel of *Rhinoceros tichorhinus* and *Rhinoceros hemitœchus.* It is certainly not of *R. tichorhinus,* and I believe it to belong, like the Cortesi cranium, to *Rhin. leptorhinus.* Cornalia has also procured molar teeth and fragments of antlers of small Deer, and some molars with a long intercolumnar pillar and prismatic form, which I regard as being of a small species of *Bos.* Lately he has acquired from the same lignite deposit some molar teeth and casts of incisors, which he finds it impossible to distinguish, whether by size or pattern of crown, from the existing Beaver, *Castor Europæus.* They are not of *Trogontherium.*

The Abbate Stoppani regards the deposit as being a late quaternary, Gandino being a spot below the horizon, to which the moraines of the southern glaciers of the Alps in Lombardy extended. On the other hand, the vertebrate remains, exclusive of the Beaver, appear to me to indicate a Pliocene age. A fragment of a Mastodon's molar, tinted black, is supposed to have come from the same deposit; but there is no certain record of its origin, and it cannot be relied upon. Nuts of a walnut of a very elongated form are very abundant in the same lignite; and one of them was got along with the Elephant's tooth. The species has been named *Juglans Berchenensis*? or some such name, by Balsamo Crivelli. The occurrence of the Beaver's teeth in this case is very remarkable, and singularly so, should it really prove to be the existing species.

Dimensions of the Cortesi Rhinoceros Skull.—1. Extreme length of skull from broken summit of occipital crest to point of the nasal bones, 28·25 in. 2. Extreme ditto from the posterior plane of occipital condyles to broken edge (anterior) of left diasteme, 27·25 in. 3. Extreme ditto from ditto, ditto, to anterior edge of alveolus of first premolar (left side), about 25· in. 4. Extreme length from anterior margin first premolar to posterior edge of last true molar, left side (last molar included in alveolus), 13· in. 5. Length of last three molars, left side, 6·7 in. 6.

Extreme length of first and second true molars, left side, 4·6 in. 7. Length of last three premolars, right side, 5·6 in. 8. Length of four premolars (to anterior margin of empty alveolus of first ditto, right side), 6·1 in. 9. Length of remaining portion of diasteme, left side (measured from anterior margin of first alveolus), 2·2 in. 10. Transverse diameter of empty alveolus of first premolar, right side, ·8 in. 11. Antero-posterior ditto of ditto, ·5 in. 12. Length of second premolar, left side (crown of tooth broken on right side), 1·95 in. 13. Transverse diameter of ditto near base, behind, 1·7 in. 14. Antero-posterior diameter of third premolar (left side), about 2·1 in. 15. Transverse diameter of ditto at bourrelet (base), anterior barrel, 2·4 in. 16. Antero-posterior diameter of last premolar, right side, outer surface (corresponding tooth, left side, broken off, and place occupied by matrix), 1·8 in. 17. Transverse diameter of ditto at base, anterior barrel, 2·25 in. 18. Length of crown of first true molar, outer surface, left side, 2·3 in. 19. Transverse diameter of anterior barrel of ditto (left side), near base, partly concealed by matrix, about 2·4 in. 20. Antero-posterior diameter, outer surface, penultimate molar, right side (crown shivered on left side), 2·4 in. 21. Interval between diastemal ridges at commencement, near first premolar, 2·85 in. 22. Length from anterior border, right orbit, to outer edge of cast of occipital plane, right side, about 16·0 in. 23. Length from ditto, ditto, to tip remaining of nasals, 13· in. 24. Length from posterior plane of occipital condyles to posterior margin of last true molar, about 13· in. 25. Diameter between outer margins of occipital condyles, 6·4 in. 26. Transverse diameter, right condyle, taken near the middle, 2·2 in. 27. Vertical height of ditto, 2·6 in. 28. Diagonal diameter of ditto (greatest), 3·2 in. 29. Width of occipital foramen (greatest), about 2·5 in. 30. Height of occipital plane to lower surface of occipital condyles, 10·5 in. 31. Greatest width of occipital plane just above the condyles, 9·1 in. 32. Greatest width of ditto about middle, 7·2 in. 33. Length of zygomatic fossa, left side, 5· in. 34. Length from the posterior boundary zygomatic fossa to the posterior surface of the occipital condyle, left side, about 8·6 in. 35. Extreme length from the tips of the incisive to the broken edge of the occipital crest, left side, measured as a straight line, 28·75–29 in. 36. Extreme ditto from the anterior margin of the orbit, right side, to the tip of the nasal, 13· in. 37. Extreme ditto, ditto, ditto, left side, to the broken edge of the occipital crest near the left summit, 16·75 in. 38. Length (versed sine) of cord stretched from greatest convexity of nasals to summit of occipital crest where slightly broken, left side, taken on plateau between the orbits, 2·3 in. 39. Length of ditto, taken at constriction of frontals between the zygomatic arches, 3· in. 40. Length from the posterior surface, occipital condyles, to tip of the nasals (a long curve), 31· in. 41. From tip of the nasals to lateral margin of occipital ridge, above the left auditory foramen, 26·5 in. 42. Length from anterior margin auditory foramen to anterior margin of the orbit, 12· in. 43. Thickness of the nasal bones taken at the middle, 1·4 in. 44. Width of ditto, ditto, 4· in. 45. Greatest contraction of the cranium between the zygomatic fossæ, 5·5 in. 46. Height of the occiput above the lower plane of the occipital condyles (occipital crest partly broken), 10·5 in. 47. Height of jaw from edge of third premolar to convexity of nasals, left side, 10·7 in.

Measurements of Lower Jaw of Cortesi's Rhinoceros.—1. Extreme length from posterior margin of ascending ramus to broken edge of incisive beak, right side, 23·25 in. 2. Length of edentulous beak from beginning of diasteme, 3·25 in. 3. Width of symphysis at contracted portion at commencement of diasteme, 2·7 in. 4. Length of line of molars, left side, as visibly exposed, 9·6 in. 4. Length of ditto, right side, ditto, 9·6 in. 5. Antero-posterior length, right side, of ascending ramus above alveolar level, 6·3 in. 6. Height from posterior angle to middle of sigmoid notch, 9·7 in. 7. Length of two last molars, left side, 4·3 in. 8. Length of anterior two, ditto, 3·1 in. 9. Length of gap between, 2·2 in. 10. Length of last exposed molar, left side, 2·2 in. 11. Length of penultimate ditto, ditto, 2· in. 12. Length of anterior molar, ditto, 1·3 in. 13. Length of second ditto, ditto, 1·6 in. 14. Height of jaw at contracted part of symphysis, 2·2 in. 15. Height of jaw to alveolar margin between first and second molars, right side, 3·6 in. 16. Interval between the posterior crescents of the last visible molars, 4·4 in. 17. Interval between the anterior edges of p.m. 2, inside, 2·7 in. 18. Interval between p.m. 3, inside, posterior margin, 4· in. 19. Interval between anterior ends of t.m. 1, 4·9 in. 20. Ditto between posterior crescents of t.m. 2, inside, 4·4 in. 21. Height of jaw to margin of alveolus of antepenultimate premolar, right side, 2·5 in.

X.—Description of Lower Jaw of Rhinoceros Leptorhinus figured by Cortesi.[1]

London, October 13, 1862.

The description which follows is believed by me to be of the missing lower jaw of Rhinoceros figured by Cortesi, and which Capellini tells me was discovered, since my visit, in a box at Parma, by Strobelli.

Among the marbles and polished stones of the Italian Court in the London Exhibition of 1862 are two rami of the lower jaw, evidently right and left of the same individual, of a fossil Rhinoceros, believed to have been sent by Professor Scacchi of Naples. The left side is entire from the ascending ramus to the symphysial margin, the condyle alone being wanting. On the right side the anterior part of the ramus, as far as the third premolar, has been crushed by a recent injury. The jaw is evidently that of an adult animal, with six molars *in situ*, all of them fully in wear, but the abrasion of the crown of the last true molar is not very far advanced. There are six molar teeth out, but no appearance of the socket of the pre-antepenultimate or first premolar. The symphysial beak is perfect on both sides, with a very short diasteme, which shows a doubtful trace of a socket for an incisor.

Dimensions:—

Length of the line of six molars, 9·25 in. Joint length of three true molars, 5·1 in. Ditto of three premolars, 3·9 in. Length of crown of last molar, 1·7 in. Greatest width of ditto, 1·1 in. Length of penultimate summit of crown, 1·7 in. Greatest width of ditto, 1·2 in. Length of antepenultimate, 1·6 in. Length of last premolar, 1·4 in. Ditto of penultimate ditto, 1·3 in. Ditto of antepenultimate ditto, 1·05 in. Ditto from anterior edge of antepenultimate premolar to incisive border, 1·7 in. Ditto of diastemal ridge, 0·65 in. Height of ramus under penultimate premolar, 2·4 in. Ditto at middle of last true molar, 2·9 in. Greatest thickness of ramus (about), 2·1 in.

The first premolar is not very far advanced in wear, the anterior part of its crown being still intact; the penultimate is further advanced, having both barrels worn so as to have confluent discs. The last premolar is nearly in the same state of wear, but less advanced. The first true molar is worn very low into a uniform sinuous depressed disc. The second is less worn, showing a horse-shoe pattern to the front division, confluent with a simple *cornu* to the hind division. The last molar has the anterior and posterior discs quite distinct and at different levels, the anterior one showing a disc of a form between a sagittate and horse-shoe pattern; the hinder disc forms a narrow band, but slightly curved into a kind of clavate form and at a much lower level than the anterior. Regarded from the outer side, the anterior barrel of the last true molar and of the penultimate shows distinctly the oblique crenate bourrelet indicated by De Christol in his *R. megarhinus*. On the right side the same bourrelet is shown on the premolars still more distinctly. The enamel surface is comparatively smooth, as in *R. megarhinus*, and perfectly free from the reticular inequalities so boldly shown in *R. tichorhinus*. On the inner side it is perfectly smooth and shows occasionally the parallel lines characteristic of *R. megarhinus*

[1] This is evidently a different lower jaw from that already described.—[Ed.]

and *R. Etruscus*. The symphysial part of the jaw and the diasteme, in their sudden abbreviation and general contour, remind me very closely of Gervais' drawing of *R. megarhinus*. Unluckily the lower surface of the symphysis is either broken or covered by matrix, so as to conceal the character there yielded by the foramina.

The left ramus on its outer surface is distinctly covered by sea-shells, some of which are of a Patella-looking form. The lower border of the ramus is nearly in a horizontal line from the posterior angle, as far as the last premolar; it then curves gently forwards to rise suddenly upwards into the beak, in a line with the anterior edge of the antepenultimate premolar. On the whole, I am satisfied that the specimen belongs to *R. megarhinus* (*R. leptorhinus*, mihi.)

The outer surface of the ramus is convex, but the inner is flat, with a broad longitudinal shallow channel. The teeth appear to have been covered with a considerable coat of cement. On the right side, at the middle of the diasteme, and about half way into the incisive border, there is an indistinct appearance of a triangular pit, as if the residuary socket of a small shed tooth; there is no such evidence on the left side, in consequence of a layer of matrix.

XI.—Rhinoceros Leptorhinus at Pisa.

May 22, 1859.

The Rhinoceros specimen from the Ardenza bone-breccia, containing the antepenultimate and penultimate true molars, left side, is not of *R. hemitœchus*, but of *R. megarhinus*.

XII.—Description of Remains of Rhinoceros Leptorhinus in the Museum at Imola.

May, 1861.

Came on last evening by Faenza from Ravenna, and went out this morning at 5 A.M., with Signor Scarabelli the Syndic, and Capellini, to see the locality where the Rhinoceros bones, &c., in the Museum were found. Drove about due S. parallel to the Santerno, towards the hills; crossed the river, and then entered a small valley, that of the 'Rio dell' Acque Marine,' where the proprietor, Signor Cerchiani, a friend of Scarabelli's, had collected through the villagers the Rhinoceros and other bones. The sections are beautifully shown, somewhat as in the Sewalik-hills.

1. Uppermost yellow quaternary loam or lehm.
2. A thick bed of stratified gravel in a hard sandstone cement, quaternary.
3. Thick beds of yellow sand, containing *Cardium edule*, &c., with occasional seams of gravelly conglomerate.
4. Blue clay, containing walnuts with elongated fruit, the same as those at Milan (p 391). Saw nothing exactly corresponding to the Sansino beds of the Val d'Arno.

Signor Cerchiani had the bones collected for him by the contadini, who found a superb skull of a fossil Rhinoceros and broke it into bits to get their separate reward for each piece, a baiocco per fragment! Scarabelli repaired the broken teeth, and has fitted the whole series of either side very cleverly into separate slabs of plaster of Paris, exactly in their

natural position, including the six molars of each side from the antepenultimate premolar (p.m. 2) to the last true molar (m. 3), inclusive. (See Plate XXXI. fig. 1.)

The molars (see Plate XXXI. fig. 1), on the whole, are admirably preserved, better even than the Bologna specimen of *R. Etruscus* (Pl. XXIX.), and in a beautiful state, so far as age goes, to show the dental characters, t.m. 2 being about half way worn above the basal bourrelet, and t.m. 3 with its apex only partially worn; p.m. 4 and t.m. 1 of either side much worn.

The following are the principal dimensions on right side:—

Extreme length of line of six molars from hind tubercle, last molar, to antepenultimate p.m. 10·6 in. Length of three true molars outside, 6·2 in. Ditto in middle, 5·8 in. Ditto of three premolars, 4·9 in. Length of p.m. 2, top, outside, 1·55 in. Width of ditto, greatest, 1·6 in. Length of p.m. 3, 1·8 in. Width of ditto greatest (below bourrelet), 2·2 in. Length of p.m. 4 ditto, 1·9 in. Width of ditto (greatest in front), below ditto, 2·3 in. Length of t.m. 1 (greater on left side, but restored), about 2· in. Width of ditto in front (bourrelet worn away), 2·45 in. Length of t.m. 2, which is very perfect, 2 3 in. Width of ditto in front, below bourrelet, 2·5 in. Length of t.m. 3 diagonally from anterior angle to basal tubercle, 2·3 in. Width of ditto at base of front barrel, 2 25 in.

General Remarks.—1. The first point that strikes is, that the three premolars have a very large basal cingulum, quite as large as that figured by Christol. It is largest in the third and fourth, and very oblique in its direction, rising gradually from the base of the anterior barrel to the top, behind, of the posterior barrel (*i.e.* from the anterior talon to the edge of the hind valley).

2. The true molars have also a very distinct basal cingulum (!). This is nearly worn away in the antepenultimate, but is shown in very bold relief upon the anterior barrel of the penultimate, and interruptedly, but quite clearly, on the posterior barrel. The same cingulum is shown very boldly on the anterior barrel of the last true molar, but is not exhibited on the posterior barrel of this tooth, which is narrow at the base.

3. In lieu of the rudimentary pit on the hind part of the base of the last true molar, which is seen in the *R. Etruscus* of the Bologna Museum, the Imola tooth (t.m. 3) shows a distinct triangular or sagittiform lobe or tubercle (like a Celtic arrow-head), adpressed to the posterior barrel, but separated from it at the apex by a very pronounced notch. This tubercle is somewhat crenated at the apex, but utterly distinct in form from that of *R. Etruscus* or *R. hemitœchus*. There is not a trace of a posterior valley running up upon the posterior angle of the last molar.

4. The vertical external furrow of the anterior angle is broad and very boldly defined by a deep groove in all the true molars, and also in p.m. 4. This is shown also in p.m. 3, but less boldly. In this respect the teeth are very different from those of *R. Etruscus*. The other ridges and furrows of the outer surface are also shown more distinctly in the Imola specimen than in *R. Etruscus*.

5. There is not the least indication of a basal bourrelet outside (as in *Aceratherium*).

6. The crochet in t.m. 2 makes an obvious angle with a re-entering nick in its offset from the posterior barrel; the angle is much more

pronounced than in the *nickless* very open angle of *R. Etruscus*, but does not form the right angle of *R. hemitœchus*.

7. P.m. 2 is about half worn, and has its anterior barrel much smaller than the posterior, like a compressed conical cup as in Gervais's figure; there are no accessory plates, but a distinct ring isolated on the base of the crochet.

8. P.m. 3 is much worn; the accessory plates are ground away, with only a sinuous outline.

9. P.m. 4 shows the same characters, but is still more worn.

10. T.m. 1 is ground down to the cingulum; the inner termination of the transverse valley shows a 'duck's-head pattern,' as in Gervais' drawings; the crochet is short and very thick.

11. T.m. 2 is in the finest condition, only about a third worn; the posterior valley is not touched behind; the crochet is thick and forms a nick at its offset, but at an open angle. There is a peculiar twist of the posterior barrel at the apex. The anterior transverse valley has a wide triangular fissure at its central termination; there are no combing plates, but there is a pillar of enamel rising in the middle of it, evidently given off from the outer ridge.

12. The last molar, as usual, is triangular, but is little worn; its anterior barrel is very broad: the posterior is narrow. There is no rudiment of a posterior valley; the middle valley is triangular, with one large combing plate converging from the outer ridge towards the crochet; there is also a similar accessory plate sent off from the anterior barrel to overlap the crochet; the three processes forming three distinct converging intrusions into the outer termination of the transverse valley.

In the Imola Museum, from near the same locality in which the skull was found, but not exactly from the same deposit, there are two rami of a jaw, each portion containing the series of molars from the second premolar to the last true molar, beautifully preserved.

Both rami are fractured anteriorly in a line with the fangs of the second premolar, and they are likewise broken posteriorly in the middle of the ascending ramus.

The lower margin is perfectly entire, but unfortunately the symphysial portion and mentary process are missing.

Dimensions on right side:—

Length of the last six molars, 8·5 in. Length of the last three true molars measured from the middle of the crowns, 5· in. Ditto of crowns of the three premolars, 3·5 in. Ditto of the last molar, 1·8 in. Ditto of the penultimate, 1·65 in. Ditto of the antepenultimate, 1·4 in. Ditto of the fourth premolar, 1·25 in. Ditto of the penultimate premolar, 1·1 in. Ditto of the antepenultimate premolar, 1·05 in. Height of the jaws between the antepenultimate and penultimate, up to the alveolar margin, 2·3 in. Height from the middle of the last molar to the alveolar border, 2·7 in.

The crowns of all the teeth are somewhat worn, *i.e.* the animal was an adult, but not old. Several of the molars of this specimen show the small characteristic *bourrelet*, which has been indicated by De Christol.

There is also a third jaw specimen—a left ramus—very well preserved, in which the molars are less worn than in the two preceding. This specimen is broken vertically in front of the penultimate premolar, and therefore exhibits only the last five molars.

Length of the last five molars, 8·2 in. Ditto ditto of three last true molars, 5·3 in. Ditto ditto of two premolars, 2·8 in.

This specimen is fractured anteriorly and posteriorly like the other two; the symphysial portion is missing. The crowns of the molars are very little worn, and are beautifully preserved; the transverse bourrelet of the outer side is well shown at the two extremities of the penultimate true molar, and is crenated. The same character is seen in the anterior portion of the last true molar, less so in the antepenultimate, and still less in the last premolar. The margin of the ramus in this specimen is exactly equal to that of the other two fossils; it belongs like them to the same species, to which the skull must also be referred, *i.e. R. leptorhinus* (Cuv. *pro parte*), *R. megarhinus* (Christol). Of the detached molars, of which there is a large number, all exhibit the characters of *R. leptorhinus*; not one can be referred to *R. Etruscus.*

There are two specimens of the last true molar, upper jaw, one right, the other left, both showing the posterior lobe, instead of the fossette as in *R. Etruscus.*

In one of the specimens, that of the right side, the crochet forms a connecting bridge, extending between the anterior and posterior portions.

XIII.—Description of Remains of R. Leptorhinus in the Scortegagna Collection at Vicenza.

May 31, 1861.

In this collection there is a lower jaw, right side, of a fossil Rhinoceros found in an osseous breccia, which corresponds exactly with the ordinary breccia of ossiferous caves. The jaw is fractured and covered with a matrix, crammed with fragments of bone. The six last molars are seen; in the first of these the crown is wanting, but the two fangs remain; the last is displaced. The first true molar exhibits De Christol's transverse bourrelet, and from all the characters it appears to me that the specimen belongs to the *R. megarhinus* of Montpellier.

Dimensions:—

Length from anterior part of penultimate premolar, to posterior portion of penultimate true molar, 7·2 in. Ditto of penultimate true molar, 2 (?) in. Ditto antepenultimate ditto, 1·75 in.

In the same collection there is shown the corresponding ramus perhaps of the same animal, with four teeth *in situ*, the last of which is very little worn. There is also a mass of matrix, containing *Cyclostoma elegans*, and several other molars of the same species of Rhinoceros, but so involved in the matrix that their crowns are not well seen.

The crown of the last true molar is worn to the middle, and has an artificial outline of wax round the posterior portion, so that all the characters cannot be seen. From what is exhibited, the specimen appears identical with *R. megarhinus.*

There is also a radius of Rhinoceros (*leptorhinus* ?). The lower part is entire, but the head is wanting, and the bone is broken in several places, so that the distinctive characters are not recognizable. It is described as a tibia of Hippopotamus.

XIV.—Note on Molars of Rhinoceros Leptorhinus (R. Merckii, Jäger), in the Museum at Stuttgart.

June 18, 1861.

Got casts of the three molars upon which Jäger founded his *R. Merckii* of Kirchberg. Dr. Fraas told me that the real history of the discovery of these specimens is involved in obscurity. They were shown to Jäger by the Prince of ——, residing near Kirchberg, and no additional specimens have turned up from that quarter. The two upper teeth are the penultimate and last, evidently of the Grays Thurrock species, *R. leptorhinus* (*R. megarhinus*). The original penultimate is in very fine preservation. [Figures of two of these casts, executed by Mr. Dinkel, will be found in Plate XXXII. figs. 1 and 2.—Ed.]

XV.—Memo. of Rhinoceros Leptorhinus from the Forest-bed.

August 25, 1863.

In Mr. Gunn's collection there is a very fine specimen of the last premolar, upper, right, of *R. leptorhinus* (*R. megarhinus*), which shows the characters perfectly and is a certain proof of *R. megarhinus* from the Forest-bed. [The characters are described in detail and are shown to differ from those of *R. Etruscus*. In a letter to M. Lartet, dated June 25, 1863, Dr. F. also remarks:—'The *Rhinoceros leptorhinus* of Grays Thurrock occurs elsewhere in England in a peat-bed, which is *below* the *loess*, along with *Elephas primigenius*.'—Ed.]

XVI.—Note on Remains of Rhinoceros Leptorhinus (R. megarhinus), in Dr. Spurrell's Collection at Belvedere.

Sept. 30, 1863.

There are four detached upper molars belonging to this species. One is a last true molar (t.m. 3), right side, in the finest preservation, and only slightly advanced in wear. In its transverse diameter from the outer angle to the inner side barrels, it agrees very closely with the Montpellier cast brought for comparison, but the width is considerably less; it shows no indication of any rudimentary basal valley behind. Another specimen of the same species is a penultimate upper left molar, which agrees in the most surprising manner in form, size, stage of wear, and hook of the posterior barrel with the *R. Merckii* cast from Stuttgart, which was brought for comparison with it. Dr. Spurrell and Messrs. Woodward and Prestwich were struck with the identity. With regard to mineral character the four teeth of *R. megarhinus* present a tint which seems to me to differ a little from that shown by the *R. tichorhinus* (see page 401), while the latter have besides a rough and rolled general character which is not so obvious in the former. On the other hand, Prestwich considers that there are three teeth of the *R. tichorhinus*, which, in mineral character, closely resemble the *R. megarhinus*, whilst the slight difference in tint may arise from difference in the facility with which the different species stain! the matrix being in both cases alike—sand with green grains of flint pebbles. He admits, however, that it is a case for inquiry.

XVII.—Note on Remains of Rhinoceros Leptorhinus in the Museum of Le Puy, Auvergne.

Sept. 15, 1863.

Examined a fine specimen of left side of lower jaw of *R. megarhinus* from Solilhac (said by M. Robert to have been found along with the bones of the skeleton which I have attributed to *R. Etruscus* !). It has the six molars *en suite*, the last but little worn. The outer side of the angle has the deep rugosities exhibited by Gervais' figure. Length of four last molars, 6·5 in.

In the same Museum there is also a magnificent palate series of *R. megarhinus* (*Merckii* pattern), according to M. Robert, found in 'des fentes à ossements éruptives du collet Polignac.' It contains the six last molars on both sides, all a little worn. Length of six molars, 11 inches. The teeth are very finely preserved, and exactly like the large Grays Thurrock specimen in the British Museum; they are very fresh and modern looking.

IV. NOTES ON RHINOCEROS ANTIQUITATIS (Blumb.) R. TICHORHINUS (Fisch. and Cuv.).

I.—Rhinoceros Antiquitatis from Wookey Hole, Taunton, and Uphill Cavern.

Taunton Museum, April 13, 1858, *and Bristol, May* 1858.

Examined upper and lower molars of *R. tichorhinus* from Wookey Hole, a lately discovered cave in the Mendip Hills. From the same cave there are molars of *E. primigenius*, a magnificent canine of the Cave Lion, remains of Hyæna, &c.

In the same Museum there is a skull of a *R. tichorhinus*, three-fourths grown, found in digging the foundation of the jail. It contains on either side the five posterior teeth, the penultimate and last in germ, and the last not fully emerged from the alveolus. There are also numerous detached teeth of the same species.

In the Bristol Museum are two lower molars of *R. tichorhinus* from Uphill Cavern, very pronounced by their rugosity.[1]

II.—Comparison of Mr. Boyd Dawkins's Specimens of Rhinoceros Molars from Wookey Hole.

March 25, 1862 [2]

They consist of two milk molars, probably from the dimensions penultimates (m.m. 3) of the upper jaw, the one (10 D) of the left side, the other (10 A) of the right; 10 A is considerably more advanced in wear than the other. There are three insulated valleys; first, there is a fissure formed by the great transverse valley, the opening of which is blocked up by a much higher step than in the same teeth of *R. hemitœchus*, in this respect agreeing with *R. tichorhinus*. There is no basal bourrelet at the inside, but in this case a small and

[1] Dr. Falconer also identified speci-____ of *R. hemitœchus* from Wookey Hole. In a letter to Col. Wood, dated July 8, 1862, he wrote: 'Mr. Dawkins lately got veritable *R. hemitœchus* from Wookey Hole'—[Ed.]

[2] In the same year Dr. Falconer identified remains of *R. tichorhinus* in collections from Kent's Hole at Torquay.—[Ed.]

rather pointed tubercle is appended to the posterior barrel. The second valley is formed by the confluence of the combing processes; it is very round and insulated, with vertical walls differing from all Colonel Wood's Gower specimens. The posterior valley is also insulated all round, with rather vertical walls. The vertical furrows upon the outer surface are well pronounced; the enamel surface, especially at the ends, is decidedly rugous; there are three fangs. I have compared it with the drawings of Colonel Wood's specimens of *R. hemitœchus*, and with the small 'Long Hole' milk molar, from all of which it is decidedly different. The smoothness and thinness of the enamel in the latter is strongly pronounced. In the form of the fissure, in the roundness of the small valley, and in the enamel surface, it closely agrees with the still more worn milk molar of *R. tichorhinus* from 'Long Hole,' Gower, and I infer it to be of *R. tichorhinus*.

10 D. resembles 10 A. very closely in all its characters, but is considerably less worn, and it shows large fangs. The large transverse valley forms an isolated fissure, with a high step blocking up its opening as in *R. tichorhinus*, but there is no tubercle. The small middle valley is a round ring with vertical walls, but not quite insulated on its inner side, there being a narrow cleft between the combing processes. The posterior fissure forms a deep and rather vertical pit, the edge of which is intact behind. In the characters of enamel surface, and outer vertical furrows, it agrees entirely with 10 A. The posterior fissure in the 'Long Hole' (Gower) specimen is much more gaping and triangular in its marginal outline, and very much more depressed at its hind border. I believe Mr. Dawkins' specimens to be of *R. tichorhinus* and not of any form of *R. leptorhinus*. The *R. megarhinus* has far more combing plates.

III.—Memorandum of Fragment of Lower Jaw of Rhinoceros tichorhinus, with Milk Dentition, from Wookey Hole.

December 7, 1862.

Mr. Dawkins' specimen is a fragment of the anterior portion of the left side of the lower jaw, containing the first three milk molars *in situ*, with about one inch of the diastemal and symphysial portions; the last milk molar (m.m. 4) is wanting. With this exception, the Wookey specimen resembles in the very closest manner the Lawford specimen figured by Owen in the 'Brit. Foss. Mam.', pp. 338 and 363, Cuts 128 and 137. The m.m. 1 is all but intact at the apex of the cusp. The m.m. 2 has the middle cusp and posterior crescent slightly abraded, but the anterior edge is intact; m.m. 3 has both crescents slightly abraded.

M.m. 1 in form is exactly like p. 1 of Cut 137, and m.m. 2 like p. 2, both of natural size and seen from inner side, the latter showing the double cusps of the middle more pronounced.

The diastemal portion, which is shown entire for about ·6 of an inch, is very rounded. The enamel is rugous and there is no cement. The jaw is low and the inferior edge is rounded forwards, and very broad and flat. There is not the least appearance of incisors or their pits. There is one large mentary foramen, at about $\frac{3}{4}$ of an inch in front of the anterior (m.m. 1) tooth, at about the middle of the height of the jaw.

The following are the principal dimensions:—

Length of fragment, 4·6 in. Joint length of three milk molars, 3·1 in. Length of m.m. 1, 0·7 in. Ditto of m.m. 2, 1·0 in. Ditto of m.m. 3, 1·3 in. Height of jaw under m.m. 1, inside, 1·6 in. Ditto at hinder end of m.m. 3, 2·0 in. Greatest thickness of ramus below, at section, 1·5 in.

The jaw at hind section is gnawed, but not deeply scored, as if by *Hyæna*.

This specimen confirms my former doubts,[1] that the Lawford specimen has the milk dentition, and not the permanent, as described in the 'Brit. Foss. Mammalia.'

IV.—Memorandum of Skulls of Rhinoceros Antiquitatis in the Stuttgart Museum.

June 18, 1861.

Saw two skulls of *Rhinoceros tichorhinus*, found in the *Lehm*, near Stuttgart; one of them very large but somewhat crushed. The molars, lower jaws, and other bones of this species, are very numerous. Looked over the whole of them, but saw nothing in the slightest degree resembling either *Rhinoceros hemitæchus*, *Rhinoc. leptorhinus*, or *Rhinoc. Etruscus*. (See *antea*, p. 398.)

V.—Molars of Rhinoceros Antiquitatis in the Collection of Dr. F. Spurrell, Belvedere.

September 10, 1863.

Of *Rhinoceros tichorhinus* there are fourteen characteristic and well-marked detached upper molars, including a pair of last (m. 3) of opposite sides. They are all highly characteristic specimens of the species, *i.e.* the enamel is thick and rough, and the valleys are three and vertical. They are in a ruder state and appear to have been rolled or tumbled about much more, than the *leptorhine* molars in the same collection. Woodward, Prestwich, and myself are agreed upon this. (See *antea*, p. 398.)

VI.—Memo. of Rhinoceros Antiquitatis in Mr. Grantham's Collection.

September, 1863.

Posterior part of the cranium of *Rhinoc. tichorhinus*, including nearly the whole of the occiput with the left condyle quite entire. The occipital crest is perfect, and on the left side the parietal and temporal regions, with the auditory foramen and the styloid process, are nearly perfect. The skull, *in situ*, was probably entire. There are also several fragments of the upper jaw containing teeth. One left maxillary contains four molars of an adult animal *in situ*. The teeth show distinctly the character of *Rhinoc. tichorhinus*. There are no lower jaw specimens, but several detached lower molars. The only remains of *Rhinoc. leptorhinus* in this collection is one molar, very far advanced in wear and very like Dr. Spurrell's (p. 398).

[1] Expressed in Note-books after examination of the Lawford and Wirksworth Jaws of *R. tichorhinus* in the Oxford Museum in 1858. See also *antea*, p. 348.—[Ed.]

VII.—Memo. of Jaw and Molars of Rhinoceros Antiquitatis in the Museum of Le Puy.

September, 1863.

Examined a lower jaw, left side, broken in front and behind, of *Rhinoceros tichorhinus*, and two detached upper and three lower molars of same species, labelled *Rhinoc. Mesotropus*, by Aymard, in his handwriting. The jaw is youngish and contains the last five molars *in situ*, the last not quite emerged. There is also a block of plaster of Paris containing four molars, not consecutive, of upper jaw, right side (*i.e.* two true molars and two premolars), named *R. Mesotropus* in Aymard's handwriting. According to Aymard, both *R. megarhinus* and *R. tichorhinus* belong to his *R. Mesotropus*. The specimens are from 'Attérissements de Paradis près Espaly.'

VIII.—Note on Specimens of R. Antiquitatis in Maidstone Museum.

September 28, 1863.

In this collection I found five upper molars of *Rhinoc. tichorhinus*, from Stroud; six upper molars, including two fine last upper, from the brick-earth at Thornhill, at back of Maidstone Jail, one of which is very remarkable and ought to be figured; the lower end of a right humerus from Burham; and the fragment of a tooth, far advanced in wear, from the railway cutting near St. Peter's Church.

NOTES ON DENTITION OF LIVING SPECIES OF RHINOCEROS.

I.—Note on Rhinoceros Keitloa.

Saffron Walden, October 8, 1861.

The Saffron Walden Museum contains a beautifully perfect skeleton of an adult Rhinoceros, got at the same time as the Elephant from Algoa Bay (see *antea*, p. 265), but the ticket indicating South Africa. It bears the name of *Rhinoceros camus* or *R. simus* of Burchell.

In the upper jaw there are seven molars all protruded, but the last true molar barely touched by wear. There are four premolars and three true molars. The premolars are surrounded by a distinct basal cingulum; but in the progress of wear only two pits have been left, and the form of the crown is exactly that of the two-horned Rhinoceros of Sumatra, and totally different from the Tichorhinus pattern. Unfortunately the two intermaxillary bones have been lost or omitted in mounting the skeleton, but it is apparent that there was a short diastemal edge in front of the first premolar.

As regards the lower jaw the dentition is quite complete. There are four premolars and three true molars, all of them affected by wear, except the last. The first premolar has a flattened crown, with a single fang, and is of moderate size, immediately in front of which is the nearly filled up alveolus of an outer incisor which had been shed, and of which the fang-pit is in progress of filling up. Inside of it there is, on either side, and immediately contiguous to it, the pit, nearly eradi-

cated, of a rudimentary incisor. There were, therefore, *four incisors* below, deciduous in the adult animal, and which were in immediate contiguity with the molar series without the interruption of a diasteme. On the whole, the dentition of this skeleton reminds me very much of that of the adult *Rhinoceros bicornis* of Africa.

There is one peculiarity in the skull deserving notice, viz. that while the suborbital foramen on the left side is single, on the right side there are distinctly three foramina disposed in a triangle. The skin of the same skeleton has been mounted, forming a very fine specimen. It presents two horns, of which the nasal is 27 inches long, and 18½ inches in girth at the base. The posterior horn is contiguous at the base with the anterior. It is of large size, measuring about 13 inches in height and 17½ inches in girth at the base. On referring to the excellent figures in Anderson's 'Lake Ngami' (p. 386), it would seem that the Saffron Walden skeleton is a *R. Keitloa*, both horns being of considerable length; in Anderson's figure they are subequal.

II.—Note on Rhinoceros camus.

In the same Museum there is also a skeleton of a little *Rhinoceros camus*. Both jaws show seven molars on each side, the seventh in the upper jaw being barely out. The front of the lower jaw shows the pits of four incisors which had fallen out, the pits being nearly filled up; the two outer are large, the two inner small. The alveolus of the outer incisor is overarched by the first premolar, there being only two lines of interval.

III.—Note on dentition of Rhinoceros bicornis.

Leeds, July 17, 1858.

In the Natural History Museum there is a very fine skull of *Rhinoceros bicornis* in the best possible age for the comparison of the dentition, but it has no lower jaw. All the permanent teeth are in place; the premolars are well worn, and the last molar is just worn sufficiently to show the pattern perfectly. The 3rd right premolar has three distinct fossettes, and the 2nd, 3rd, and 4th have a distinct basal bourrelet on the inner side very salient and marked, and continuous with the anterior and the posterior bourrelet. There is no inner bourrelet to the three last molars. The last molar has an interior bourrelet, but only one or two warty tubercles posteriorly. The posterior barrel is bifurcate. There is a very minute rudimentary incisor in the incisive bone on the right side.

VI. NOTE ON THE EXISTING HIPPOPOTAMUS LIBERIENSIS (MORTON), WITH A SYNOPSIS OF THE HIPPOPOTAMIDÆ, FOSSIL AND RECENT.[1]

DR. MORTON'S discovery is one of the most interesting and remarkable made in Zoology during the present century. Cuvier, in his 'Discours Préliminaire,' has entered into an elaborate argument against the probability of any remarkable existing large species of land animal remaining to be discovered, after the search which has been made through the continents and great islands of the globe. Dr. Morton's discovery proves that the inference was premature.

Hippopotamus Liberiensis is perfectly distinct from *H. amphibius*. It differs more from the latter than *H. amphibius* does from *H. major* and *H. palæindicus*, the only two fossil species of the same subgenus of which the crania are known. The distinctive characters are very strongly marked, and are chiefly the following, viz. the length of the cranium proper as compared with that of the face; the advanced position of the orbits, which are nearly in the middle of the head; the convexity of the forehead, both from back to front and across the orbits; the less hooking forwards of the leafy expansion and the greater elevation of the coronoid process of the lower jaw, as well as the absence of any diasteme. The dental characters are also different. The trefoil disc of wear in the true molars is exactly as in *Hippopotamus amphibius*, but the canine teeth of the upper jaw alone, without reference to the dimensions and other peculiarities, would establish the distinctness of the species. In *H. amphibius* and *H. major*, the internal vertical channel is shallow; while in *H. Liberiensis* it is so deeply grooved as to yield a strongly marked reniform outline in the section. This character is of especial interest, as it is constant and nearly to the same amount as in an Indian fossil species of the subgenus *Hexaprotodon*, viz. *H. Sivalensis*. The lower tusks resemble closely those of *H. amphibius* in form and direction. There are four incisors in the upper jaw which are slightly curved and nearly vertical. In the lower jaw there are only two incisors, which are much stronger than those in the upper jaw and project almost horizontally forwards. It would appear to be the intermediate incisor which is alone developed on either side.

[1] In 1847 Dr. Morton transmitted his specimens to London, to be examined by Dr. Falconer, who contributed the greater part of this note to Dr. Morton's essay which was published at Philadelphia in 1849. Additions have been made to the original note from the author's Note-books. The Synopsis of *Hippopotamidæ* and the Memorandum of the Hippopotamus skull at Dublin have also been extracted from the Note-books.—[ED.]

Measurements of Hip. (*Tetraprotodon*) *Liberiensis.*—From occipital crest to anterior margin of incisive bone, 12·8 in. From ditto to tips of nasals, 11·8 in. Width between posterior borders of orbits, 5· in. Width between anterior ditto at foramen, 3·6 in. Greatest width zygomatic arches (½ 3·9), 7·8 in. Width of occiput, 3·1 in. Width of head at contraction (orbit. foramen), 2·5 in. Width of ditto at bulges of canine alveoli, 5·25 in. Width of incisives, 3· in. Height of head to margin of alveolus at suborbital foramen, 3.5 in. Length from occipital crest to suborbital foramen, 7·75 in. Length from ditto to posterior border orbit (posterior orbital foramen), 4·75 in. From ditto to anterior border of ditto, 6·25 in. Antero-posterior diameter orbit, 1·9 in. Vertical ditto, 2·1 in. Interval between interior surface of zygomatic arches at point of greatest expansion, 7·6 in. Length of alveolus at margin of molars, 6· in. Interval between anterior false molar and canine, 0·25 in. From ditto to inner margin alveolus, middle molar, 2·1 in. Width of palate between the tusks, 2·75 in. Width between the outer incisors, 1·75 in. Width between outer false molars, 2· in. Width between third false molars, 1·4 in. Length of three posterior true molars, 3·1 in. Width of forehead between middle of orbits, 3·75 in. Interval between middle incisors, 1· in. Length of alveolar margin of two incisors (of one side), ·9 in. From anterior margin of orbit to tip of the muzzle, at middle incisor, 7· in. From ditto to crest of occiput, 6·5 in. Length of nasal bones, 6·1 in. Depth of nasal opening, 1·75 in. Transverse diameter of nasal opening, 1·75 in. Interval between tips of posterior orbitary processes, 1·1 in. Transverse diameter of tusk, 1·1 in. Vertical diameter of ditto, ·8 in. Depth of reniform channel, 0·4 in. Diameter of outer incisor, ·4 in. From anterior margin of orbit to orbitary foramen, 1·75 in.

Lower Jaw.—Extreme width of alveoli of tusks, 4·5 in. Interval between canines, 2·8 in. Interval between canine and incisor, ·5 in. Interval between incisors, ·8 in. Diameter of left lower incisor, ·55 in. Between tusk and first false molar, ·4 in. Length from posterior margin of condyle to tip of muzzle, 10· in. Length from posterior margin ramus to ditto, 10·25 in. Length of symphysis, 2·8 in. Width of jaw at contraction below third false molar, 3·75 in. Width behind, in front of niche, 5·3 in. Greatest expansion of leafy dilatation below, estimated, 9·0 in. Extreme height from lower margin of expansion to tip of coronoid, 5·9 in. From anterior margin coronoid to posterior ditto of condyle, 2·5 in. Height of leafy expansion to niche in front of condyle, 4·6 in. Height of jaw to margin of alveolus between second and third false molar, 2·15 in. Height of jaw at last molar, 1·9 in. Width of condyle across, 1·25 in. Interval between first false molars, 2·6 in. Interval between third false molars, 2·0 in. Length of three posterior molars, 3·4 in. Length of alveolar border, four false ditto, 3·15 in. Length of leafy expansion, 3·5 in.

Hippopotamus comprises two Subgenera, *Hexaprotodon*, with six incisors above and below, and *Tetraprotodon*, with reduced incisors, viz. four above and below. *Hip. Liberiensis*, although it has but two incisors in the lower jaw, belongs to the latter subgenus; the excessive reduction is probably only an individual case of variety, but if proved to be constant the position of the species would not be altered. The succession of the species in the subjoined synoptical table indicates the order of their affinities. No. 1, *H. major*, is the most divergent form, with short cranium, posterior orbits, great elevation of the sagittal and occipital crests, and excessive elevation of the upper margin of the orbits above the plane of the brow. Next follows *H. palæindicus*, a true fossil Hippopotamus from India. Then comes *H. amphibius*, No. 3 in the series, of which the French naturalists make two species, *H. Capensis* and *H. Senegalensis*. Duvernoy (Comptes Rendus, Oct. 1846) maintains their distinctness, but I regard them as merely varieties. *H. Pentlandi* (No. 4) is the fossil species which prevails in Sicily, Malta, and Candia. *H. annectens* (No. 5) is a fossil species from the Nile

above the Cataracts, which was brought to Europe by Dr. Rüppell in 1827, and which I have examined in the Frankfort collections (the Senckenberg Museum). I have named it provisionally *H. annectens*, from its forming a link in size between *H. amphibius* and *H. Liberiensis*. The cranium is not known, and further investigations may show that it is identical with *H. Pentlandi*. Cuvier's *H. medius* has proved to be a species of Dugong (Halitherium). Next follows Cuvier's *H. minor* (No. 6), which is a doubtful *Tetraprotodon*. I range *H. Liberiensis* (No. 7) last, from its close resemblance to the Indian *Hexaprotodons*, in the form of the upper canines.[1]

Of *Hexaprotodon* there are three well-marked Indian species. *H. Iravaticus* (No. 8) is a size larger than *H. Liberiensis*. *H. Sivalensis* (No. 9) is less than *H. amphibius*; and *H. Namadicus* (No. 10), with other strongly marked characters, is larger than *H. amphibius* or *H. Sivalensis*. There are portions of every part of the skeleton showing the closest resemblance to *H. amphibius* throughout, though it is more slender in its proportions.

Merycopotamus is a most interesting and well-marked genus, connecting *Hippopotamus* with *Anthracotherium*. The molar teeth, as in the latter, are constructed on the ruminant plan; while the cranium, incisors and canines, together with the leafy expansion of the angle of the lower jaw, connect it with the former. It was nearly of the size of *H. Liberiensis*.

SYNOPSIS OF HIPPOPOTAMIDÆ.

Gen. I.—Hippopotamus.

Subgenus I.—*Tetraprotodon*.

1. Tet. Major (Cuv.), European fossil, figured in 'Fauna Antiq. Sival,' Plate LXII.
2. Tet. palæindicus (Falc. and Caut.), Indian fossil, from the Valley of the Nerbudda, figured in 'Fauna Antiq. Sival.,' Plates LVII., LVIII., LXII.

[1] *Note on a remarkable Hippopotamus Skull in Mr. Ball's Collection at Dublin.*—The specimen is the large end of the skull of an adult, but not old, animal. The rear back molar in both jaws is developed, and worn down on the left side into a trefoil; it is intact on the right. There are six molars on the left side of the lower jaw; there are five on the right, the anterior being missing. There are seven molars on the right side, upper jaw, the anterior being isolated, and placed about one-third forward on the diasteme. There are six only on the left, the anterior one being wanting. The lower jaw is very remarkable, the anterior part being unsymmetrical, with three incisors on the right side! and only two as usual on the left. The supplementary incisor about 1 inch projecting, and between a swan-quill and tip of little finger in thickness. It is projected in the same plane as the middle ones, being about one-third of the distance from the canine, and two-thirds from the next incisor. The canine of the same side diverges very much outwards, while on the left side it is erect. Further, there is a supplementary slip of a separate tooth placed like a splint on the inside and angle of the right canine in the same sheath, and projecting about an inch. The upper and lower right canines had not been in contact to wear; there is an interval of two or three inches.

3. Tet amphibius. Africa, living, figured in 'Fauna Antiq. Sival.,' Plate LXII.
   Var. *a*, Tet. Capensis.
   Var. *b*, Tet. Senegalensis.
4. Tet. Pentlandi.
5. Tet. annectens, Nubian fossil.
6. Tet. minor (Cuv.), fossil.
7. Tet. Liberiensis, living.

Subgenus II.—*Hexaprotodon*.[1]

8. Hexap. Iravaticus (Falc. and Caut.), Indian fossil from Ava, figured in 'Fauna Antiq. Sival.,' Plate LVII.
9. Hexap. Sivalensis (Falc. and Caut.), Indian fossil from Sewalik hills, figured in 'Fauna Antiq. Sival.,' Plates LIX., LX., LXI., LXII., LXIII., LXIV., LXV., LXVI.[2]
10. Hexap. Namadicus (Falc. and Caut.), Indian fossil from the Valley of the Nerbudda, figured in 'Fauna Antiq. Sival.,' Plates LVII., LVIII.

Gen. II.—Merycopotamus.

1. Merycopotamus dissimilis (Falc. and Caut.), Indian fossil from Sewalik hills, figured in 'Fauna Antiq. Sival.,' Plates LXII., LXVII., LXVIII.[3]
2. Merycop. nanus (Falc.).[4]

[1] The reader is referred to a paper by Dr. J. McLelland, 'On the genus *Hexaprotodon* of Falconer and C[illegible]—Journ. As. Soc. Dec. 1838, vol. vii. p. 1038.—[Ed.]

[2] See also vol. i. Plates xi. and xii.—[Ed.]

[3] See also vol. i. Plate xiii.—[Ed.]

[4] In Plate lxvii. of the 'Fauna Ant. Siv.' two varieties of Merycopotamus are figured: 'M. major' and 'M. minor,' and in one manuscript note written in 1816, by Dr. Falconer, the genus is divided into two species, viz. *M. dissimilis* and *M. nanus*. This suspicion as to two species seems to have been confirmed by a specimen from Attock sent to the author in 1857 by Dr. Oldham. This was the last upper molar, and was compared with the corresponding tooth of *Merycopotamus dissimilis* in the British Museum (No. 1075 A) with the following result:—

	Mer. dis.	Mer. of Attock
Length of last molar .	1·1	0·75
Width of ditto in front	1·2	0·8

The author adds: 'The difference in area is so great that the Merycopotamus of Attock must have been a distinct species.'—[Ed.]

VII. DESCRIPTION OF TWO SPECIES OF THE FOSSIL MAMMALIAN GENUS PLAGIAULAX FROM PURBECK.[1]

Until very lately, the only fossil mammifer known to science from the Upper Oolite beds (Purbeck series) was the *Spalacotherium tricuspidens* of Professor Owen, a small insectivorous form referred by him, with some reserve, to the placental series.[2] It was discovered by Mr. W. R. Brodie in one of the so-called 'Dirt-beds' of Durdlestone Bay, Purbeck. That meritorious collector continued his researches during the years 1855 56, and had the good fortune to discover some other mammalian remains, which were transmitted to London about the end of last December for description by Professor Owen. They were all found in what is called the 'Dirt-bed' No. 93, of Austen's 'Guide.' Before these remains had reached London, Mr. Samuel H. Beckles, so favourably known from his researches in Sussex and the Isle of Wight, after free communication with Sir Charles Lyell about the importance of a close and sustained search for mammalian remains at Purbeck, proceeded to Swanage for the express purpose of carrying it out. Before a fortnight had elapsed, Mr. Beckles, by a series of well-directed excavations, had discovered several mammalian jaws besides numerous reptilian remains, in the 'Dirt-bed' No. 93. When the first line of section ceased to be productive, or could no longer be worked, he opened new ground, under difficulties which would have damped the ardour of a less earnest inquirer. The labours of Mr. Beckles have been crowned with the success which they deserved. He has discovered a large number of mammal remains, many of which are new, and in very fine preservation. The united acquisitions of Messrs. Brodie and Beckles have already attained the important figure of about thirty mammalian jaws, more or less complete, the majority of them lower, but two, at least, upper

[1] This paper was communicated to the Geological Society of London on March 11, 1857, and is reprinted from the 'Quarterly Journal' of the Society for August, 1857. The illustrations have been reproduced on stone (Plates xxxiii. and xxxiv.) from the original woodcuts.—[Ed.]

[2] Quarterly Journal of the Geological Society, vol. x. pp. 431 and 432, 1854.

jaws, with one well-pronounced cranium. The most important portion of these are the discovery of Mr. Beckles.

The explorations have been conducted under a conjunction of unusually favourable circumstances. Sir Charles Lyell gave his sage and long-experienced advice with the deep interest in the case which befits the author of the 'Principles of Geology;' Professor Owen aided the good cause by keeping Mr. Beckles advised of the importance of the additions which he was making to Palæontology; and, having had the leisure, from confinement to my rooms by indisposition, to examine the objects as they were successively discovered and forwarded to me, I was enabled to communicate to Mr. Beckles, constantly, an approximative opinion as to the nature of each fresh acquisition, and thus encourage him to persevere. From his correspondence, apart from the results, I can bear testimony to the rare zeal, minute care, and admirable vigour with which Mr. Beckles has followed up the inquiry. So productive have his labours been latterly, that hardly a week passes without its regular instalment of a couple of dispatches of mammalian jaws from Purbeck.

It is intended that, when the collection is completed, the Purbeck Fossils shall be made over to Professor Owen for description and publication; and, from what is already manifest, it may safely be stated, that they will furnish materials for one of the most interesting and important of the many chapters which our distinguished countryman has contributed to the record of Mammalian Palæontology. Without forestalling Professor Owen's detailed results, I may be permitted to state that I have satisfied myself of there being among the Purbeck fossils at least seven or eight genera of Mammalia, some of them unquestionably Marsupialia, both predaceous and herbivorous; and others of them conveying to my mind the impression, so far as the evidence goes, that they belong to the Placental Insectivora, having affinities more or less remote to existing types.[1]

[1] Eight genera, comprising at least twelve new species, received provisional names from Dr. Falconer, before the specimens were forwarded to Professor Owen. One was believed to be a minute placental insectivore, closely allied to the insectivorous genus *Ericulus* peculiar to Madagascar. Another lower jaw indicated an insectivorous mammal of fair size, leaning to the placental, and with affinities to the European *Talpidæ*. One was allied to the type of the marsupial *Amphitherium* of the oolitic slates of Stonesfield, though generically distinct. In this species the jaw, according to Dr. Falconer's notes, had an elongated slender ramus, containing 7 uniform back molars *in situ*, and the empty alveoli of 4 or 5 false molars in front, together with a prominent laniariform tooth. The dental formula agreed numerically with that of the *Amphitherium*, but differed from it in the double-rowed and complex arrangement of the crown cusps. Two other species (afterwards designated *Triconodon* by Professor Owen) Dr. Falconer inferred to be carnivorous marsupials. The smaller one was believed to have been nearly as large as the common hedge-hog.

Having undertaken a description of one of the most remarkable of these Purbeck mammal genera, in compliance with the expressed wishes of Mr. Beckles, to accompany some illustrations which will appear in Sir Charles Lyell's forthcoming Supplement to the 5th edition of the 'Manual of Elementary Geology,' I have thought it desirable to place the anatomical evidence for the results more in detail than could be admitted in a brief abridgement in that work.

The genus '*Plagiaulax*,'[1] which is inferred to have been herbivorous and marsupial, comprises two well-marked species, *Pl. Becklesii* and *Pl. minor*. It has been determined upon two distinct specimens, which were among the earliest of Mr. Beckles' acquisitions, each a right ramus of the lower jaw. Latterly, two additional specimens[2] have been received of the larger form, *Pl. Becklesii*, supplementing important points of evidence which were wanting in the first instance. The illustrations and descriptions now submitted are derived chiefly from the two original specimens. Of these, the one of *Plagiaulax Becklesii* (Plate XXXIII. figs. 1 & 4, *a*, *b*, and *b*, *d*), in two pieces on reversed slabs, consists of the lower jaw, right side, perfect from the tip of the incisor to the proximal surface of the condyle, including the ascending ramus and coronoid, with the exception only of the raised

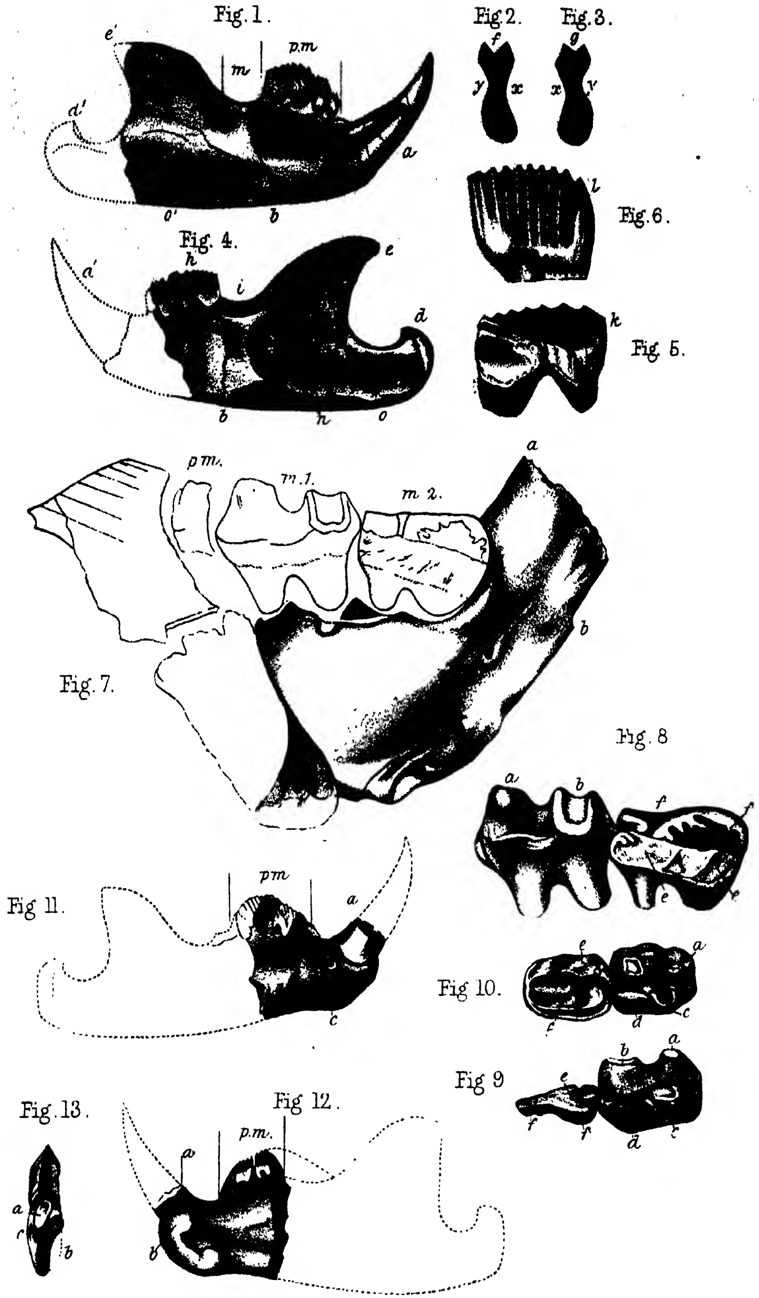
The lower jaw contained eight molars, a large and prominent canine, and one broad and thick incisor on each side. 'The compressed crowns of the interior molars in this *Triconodon* have each of them three sub-equal sharp-pointed cusps, rising nearly vertically into the same longitudinal plane, with basal end lobules, but without additional interior complication. They are so arranged, in a continuous and compact series as to present a uniform serrated edge, like the teeth of a saw. Similar tricuspid teeth of larger dimensions indicated the existence of another species of *Triconodon* of a more elongated form, and about one-third larger in size. Dr. Falconer noted the following evidence as to its marsupial character: '1. The plurality of true molars. 2. The strong inflected angular process. 3. The most significant proof is the broad salient everted rim of the ridge which is decurrent on the outer side from the condyle along the inferior margin, exactly as in the carnivorous marsupials. 4. The marked development of the mylo-hyoid groove.' 'The two species of *Triconodon* from the cutting character of their teeth, and their comparatively formidable canines, together with the form of the ascending ramus, are more like small ferine animals than mere insectivorous marsupials. It is more probable that they fed on prey less minute than insects.'

Two other species had dental characters closely allied to those of the marsupial herbivore *Hypsiprymnus*, or kangaroo rat, of Australia.

Lastly, there were numerous remains of a reptilian form, which Dr. Falconer intended describing in a memoir to the Royal Society, under the designation of *Saurechmodon* (the essential part of the term being derived from αἰχμ reference to the spear-head form of the teeth), when the specimens were consigned for description to Professor Owen, who designated it *Echinodon Becklesii* (Fossil Reptiles of Purbeck Strata.—Palæontograph. Soc. 1860.—[ED.]

[1] An abbreviation for 'Plagiaulacodon,' from πλάγιος, *oblique*, and αὖλαξ, *groove*, having reference to the diagonal grooving of the premolars.

[2] A fifth specimen, subsequently acquired, is described in the sequel (see Pl. xxxiv. fig. 1).



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Plagiaulax Becklesii.

posterior lower margin and inflected angle; it shows three premolars (*p*, *m*) *in situ*, with the empty sockets of the two back molars. Another specimen (Pl. XXXIII. fig. 7) fortunately supplies these two back molars *in situ*. The lower jaw (also of the right side) of the other species, *Plagiaulax minor* (Plate XXXIV. fig. 2), is less perfect. It contains all the teeth *in situ*, beautifully preserved, but it is mutilated vertically behind the alveolar border; the ascending ramus, with all the proximal portion, being wanting. Besides the two true molars, it contains four premolars instead of three, as in the other species.

Teeth.—Together, these specimens furnish nearly complete evidence as to the characters of the lower jaw of the genus. And, first in regard to the teeth, the dental formula is:—

$$\text{incis. } \overline{1-1}\text{; can. } \overline{0-0}\text{; prem. } \overline{3-3}\text{; mol. } \overline{2-2} = 12 \text{ in } \textit{P. Becklesii.}$$
$$\text{prem. } \overline{4-4} \qquad = 14 \text{ in } \textit{P. minor.}$$

To save unnecessary technical details by reference to a well-known existing genus, which will constitute in other respects an important term of comparison, it may be stated at once that the incisor of *Plagiaulax Becklesii* (Pl. XXXIII. fig. 1, *a*, and Pl. XXXIV. fig. 1), in every particular of form, namely, edge, point, and section, and in relative amount of projection, bears a very close general resemblance to the incisor of the marsupial *Hypsiprymnus*, or Kangaroo Rat, of Australia; it differs chiefly in being, for the relative size, more robust and curved more abruptly upwards, in the fossil animal. Its line of implantation in the socket is more vertical, and the alveolar sheath shorter and thicker. The diasteme is exceedingly abbreviated, not exceeding a line in length.

The three premolars, in *Pl. Becklesii* (Plate XXXIII. fig. 1, *p*, *m*), are in the finest state of preservation, showing the details of every minute character. They are limited to three in all the specimens (see Plate XXXIII. figs. 4, 11, 12, and Pl. XXXIV. fig. 1). This is a point of some importance to establish distinctly, as there are four of these teeth in the other species. They form a closely adpressed and compact series of very unequal size, diminishing rapidly in succession from the last to the most anterior. The last premolar (Pl. XXXIII. fig. 5) presents a square oblong side, convex from back to front, and sloping upwards and inwards to the edge, which is finely serrulated, as in *Hypsiprymnus*, the serratures being caused by the terminations of about seven well-marked parallel grooves, which descend upon the side, not vertically as in *Hypsiprymnus* (Plate XXXIII. fig. 6, *l*), but

diagonally downwards and forwards, disappearing about the middle of the crown-side, upon a smooth and discoidal surface. The enamel below the four last grooves is inequal and raised into a well-marked crenated step (Pl. XXXIII. fig. 5), which is exhibited on all the specimens. The interior surface being adherent to the matrix, the characters of the inner side of the last premolar are not shown by this specimén. But in two of the other specimens the inner surface of all the premolars is free and seen to be furrowed by diagonal grooves, exactly like the outer, the principal difference being that the inner side is more flattened, and the enamel smoother than on the outer. The two sides, therefore, slope from the base upwards to a sharp or thin edge, which is serrulated, agreeing in every respect, except the inclination of the grooves, with the corresponding tooth of *Hypsiprymnus*. The tooth is implanted by two distinct fangs. The penultimate premolar is somewhat spathulate in outline, the lateral surface of the crown is convex in the longitudinal direction, and slopes inwards to the apex, which is diagonally grooved like the last premolar, the grooves being fewer in number. It is inserted by two inequal fangs, the posterior of which is barely visible; in size it corresponds with one fang division of the last premolar. The antepenultimate or anterior premolar is greatly reduced in all its dimensions, being hardly one-fourth the size of the tooth immediately behind it; in form it exhibits more the ordinary appearance of an incisor.

In the other species, *Plagiaulax minor* (Plate XXXIV. fig. 2), which is very considerably smaller, the incisor (*a*) presents a corresponding general form, but it is more elongated, less robust, and is not so much curved upwards. A portion of the point has been broken off in the specimen, and it is seen by the impression (*a'*) that the inner side near the apex was hollowed out in a longitudinal depression. The premolars, in number four, are higher in proportion to the depth of the jaw than in the other species. The last one is similar in form and grooving to the corresponding tooth in *Plagiaulax Becklesii*, but exhibits a slight difference in the inequality of the enamel-surface below the basal terminations of the grooves. In front of it there are two spathulate premolars, *i.e.* the antepenultimate and penultimate, both diagonally grooved near the apex; and at the base of the antepenultimate, but pressed somewhat inwards, there is a very minute anterior or first premolar. The basal enamel-surface bulges out over the fangs in these teeth in a rounded angle which points downwards. Regarded as a series, they decrease in size very rapidly from the last to the foremost. The sharp edge of the crowns of the three anterior teeth slopes down

towards the diasteme from the anterior margin of the last premolar; while that of the latter slopes in a reverse manner downwards and backwards towards the true molars, the anticlinal planes meeting at an obtuse angle.

The true molars in both species were limited to two, the sockets of which alone remain in the more perfect jaw (Plate XXXIII. figs. 1 and 4, *m* and *i*). But they are shown *in situ*, in the most perfect preservation, in the jaw of *Plagiaulax minor* (Plate XXXIV. fig. 2, *m*). It is clearly apparent from the relation of the second tooth to the mutilated base of the anterior margin of the ascending ramus (*b*) in the latter, and from the empty sockets of the fallen teeth in the alveolar rim of the perfect specimen (Plate XXXIII. fig. 4, *i*) of *Pl. Becklesii*, that the true molars in the lower jaws of both species did not exceed two, a very unexpected and reduced number to occur in forms otherwise inferred to be marsupial, and therefore demanding rigorous determination, there being no other corresponding instance known within the whole range of this sub-class, fossil or recent.

Fortunately the specimen represented by figs. 1 and 4 of Plate XXXIII. shows the whole of the teeth of *Pl. Becklesii* in nearly as perfect preservation as they are in the specimen of *Pl. minor* (Pl. XXXIV. fig. 2). It consists of a right lower jaw in two continuous fragments, presenting the two last molars of an adult animal, well worn and *in situ*. The anterior edge of the ascending ramus is entire, forming a well-defined boundary to the alveolar border, and so closely contiguous to the second and last true molar, which it partly overlaps, that it is manifest there could not have been more than two of these teeth in the jaw. The true molars are not only reduced in number in *Plagiaulax minor*, but they are also dwarfed in size, and comparatively insignificant in contrast with the last premolar, the united length of the two being less than that of the latter, while the vertical height of their crown is little more than one-third of that of it. They are situated both horizontally and vertically in different planes from the premolars; a perpendicular from the acute serrated edge of the latter would coincide with the line of the inner row of the crown-lobes of the true molars, to be described in the sequel, as occurs in the recent *Hypsiprymnus*; and the outline of the coronal surface of the whole molar series would be included within a curve, of which the last premolar formed the most salient part, with a considerable descent on either side of it.

The crown of the first true molar in *Plagiaulax minor* (Plate XXXIV. figs. 3 and 4), which I take first as the more perfect, is of a broad oblong form. Its inner or axial margin

supports two well-raised and bluntly conical points or tubercles, separated by a wide cleft, which is partly continued down upon the body of the tooth, vertically in a sinus, forming an obsolete mesial constriction. The points are isolated and start up in considerable relief. The outer edge of the crown is not divided correspondingly; it supports mesially but a single prominent conical tubercle, which is intruded upon the plateau of the crown, and opposed to the sinus between the two inner points. It alternates therefore with the latter. The base of the outer point is continued on either side, backwards and forwards, in a well-marked lunate bevelled rim, which is convex outwards, and rises at either end into a low terminal lobule. The posterior lobule may be considered as the homologue of the posterior inner point, although it forms but an insignificant tubercle. The anterior lobule is still less developed, but opposed to the anterior inner point. The middle of the crown is occupied by a sinuous hollow surface, intervening between the outer and inner rows. This hollow, from the intrusion of the outer mesial point and the constriction of the inner side, is divided into an anterior and posterior discoidal depression. The two rows are separated at both ends of the tooth by a longitudinal chasm. There is no indication of any low transverse concave ridge connecting the opposed tubercles. From the above description it will be seen that the two sides are unsymmetrical, whether the outer row is considered as consisting of a single point with an accessory tubercle on either side, or of three unequal tubercles.

The second or last true molar (Pl. XXXIV. figs. 5 and 6), viewed in profile, is smaller than the first, and the crown-surface, although of nearly equal extent, is less complex in its subdivision. It is of a broad oval, with the base applied to the contiguous anterior tooth. The coronal eminences consist of an outer and inner raised marginal and more or less lobulated edge, separated by a broad central depression. The outer edge is very narrow and nearly horizontal, rounded off at either end and presenting no marks of composition beyond four or five obscure indications of crenulation, like one of the rows in the tooth of *Microlestes* (see Pl. XXXIV. fig. 7). It is incurved so as to overarch slightly the central depression. The inner edge presents at its anterior end a well-elevated and isolated conical tubercle, resembling in size and form the outer mesial point of the first true molar. It is bounded posteriorly by a deep wide cleft from which a convex edge is continued backwards, which is raised, but not sufficiently to attain the importance of a cusp, although homologous to the rear cusp of the anterior tooth. The

centre of the crown is occupied by a hollow—smooth, and, as it were, scooped out and depressed considerably below the raised margins. A well-marked chasm intervenes between the marginal edges, both in front and behind, the latter being narrower and less pronounced, so that when the tooth is viewed endwise, the opposite rows are seen apart somewhat as in the tooth of *Microlestes*. The crenation of the outer margin into a row of tubercles is more decided in *Microlestes*[1] (Pl. XXXIV. fig. 7), the crown is narrower and more elongated in proportion, and the opposed rows are more approximated. None of the raised points of these teeth in *Plagiaulax minor* show any considerable marks of abrasion, nor exposure of the ivory; the white spots in the figures represent adherent specks of matrix, and not depressed discs of wear; the apices of the outer crenations alone are a little worn in the last molar. The animal from which the fossil was derived is inferred, from the intact condition of the molar teeth, to have been a young adult, as these teeth have been found well worn in one specimen of the other species.

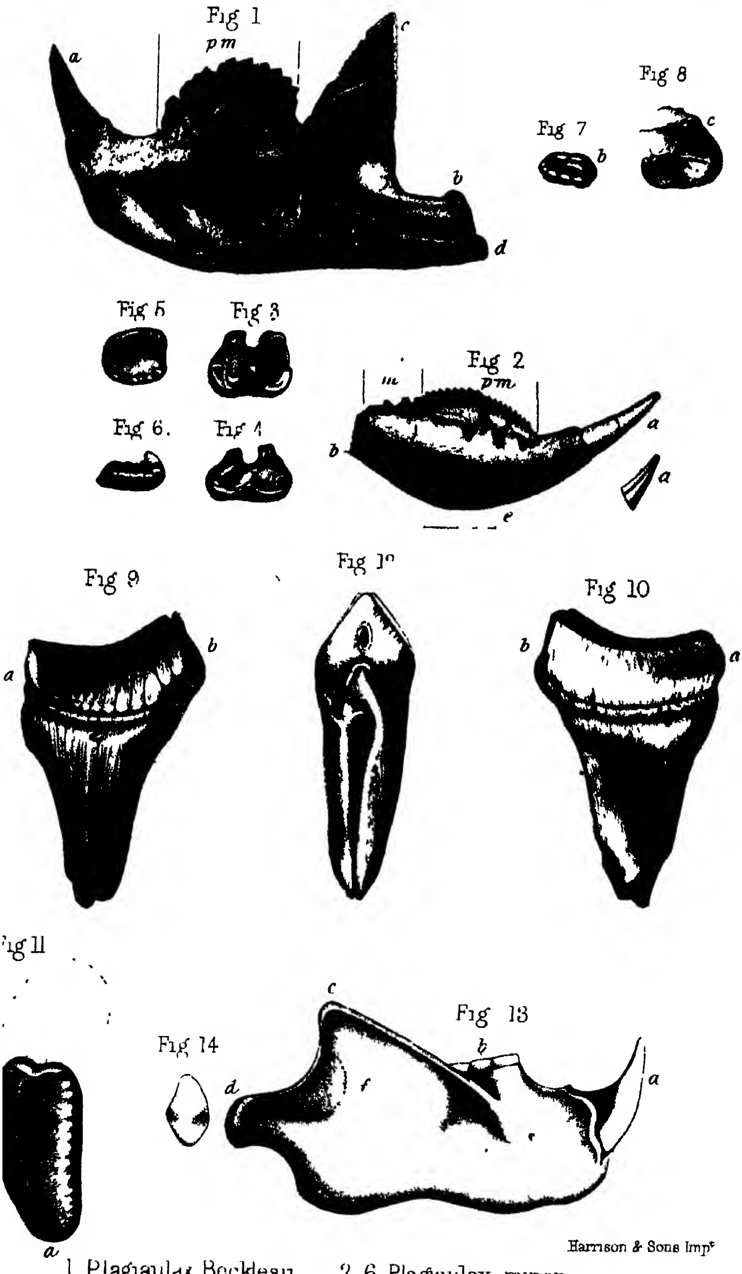
In the jaw of *Plagiaulax Becklesii* (Pl. XXXIII. figs. 1 and 4), there are three small pits on the alveolar border, behind the last premolar. The anterior two, seen upon the fragment fig. 1, *a*, *b*, are closely approximated, with a thin plate intervening, indicating that they are the sockets of the two-fanged first molar. One of them is shown in the niche at the apex of the vertical sections, Pl. XXXIII. figs. 2 and 3, *f*, *g*. The last pit, fig. 4, *i*, is larger, square, and undivided, but shows obsolete marks of a mesial constriction, indicating that the second or last molar had fangs converging in a common socket. The rim of this socket is distinctly defined, and the inner wall raised into a prominent gibbosity which leaves a deep impression on the matrix. This gibbous point corresponds with what occurs in the lower jaw of the recent *Hypsiprymnus Gaimardi*, with which it was compared, and is commonly seen on the alveolar wall of the last molar of other animals.

In the second specimen of *Plag. Becklesii*, Pl. XXXIII. figs. 7-10, already referred to, the two true molars of an adult, and, judging by their wear, well-aged animal, are seen *in situ*. They present the same general characters as the corresponding teeth of *Plag. minor* (Pl. XXXIV. fig. 2), but appear to be proportionally larger, in comparison with the premolars. The crown of the first molar bore, as in the other species, three principal points; two to the inner row;

[1] I am indebted to Sir Charles Lyell for the only available means of instituting a comparison of these mammalian teeth from Purbeck with those of the *Microlestes* of Plieninger. Besides several duplicate casts, he had very careful and highly finished drawings made of the teeth during his last visit to Stuttgart, the whole of which have been placed at my disposal.

and to the outer a single tubercle, which is situated more anteriorly than in *Plag. minor.* The outer point is worn down and indistinctly defined, the wear involving what appears to have been the bevelled lunate rim at the posterior end, as described in the other species. It is not determinable whether it attained the magnitude of a separate tubercle. The two inner points form obtusely conical tubercles, which are in greater relief, and less affected by wear; so that the worn disc of the outer row looks like a step at their base. Of these tubercles the anterior bears an accessory lobe which is continued across in a front talon, giving a bilobed character to the point, which is but slightly abraded at the apex: while the posterior point shows a well-marked depressed disc, which is continued some way down upon the inner side of the enamel, as if caused by the grinding play of an overlapping cusp of an upper tooth in use against it. The longitudinal furrow between the two rows is distinctly visible. There is a well defined basal cingulum to the last molar in this species. The inside elevation of the last true molar agrees very closely with a corresponding view of the larger tooth of *Microlestes antiquus*, as represented in one of the drawings belonging to Sir Charles Lyell (Pl. XXXIV. fig. 8). The second and last true molar presents a nearly square crown with rounded angles. It is fully equal in size to the penultimate, if not a little larger. The crown bears two marginal edges, as in the other species, with a well-marked depression between them. The inner edge is broken off and seen embedded in the matrix of the opposite slab. The outer edge is entire, but ground down by wear, so that it shows a marginal band with no remains of crenation. The detrition of the crown, as a whole, bears some resemblance to that seen upon the last molar of an aged Bear; the comparison, be it understood, not being intended to imply the slightest idea of affinity. The angle formed by the anticlinal planes of the crowns of the true molars and premolars is more acute in the jaw of *Plag. Becklesii* than in that of *Plag. minor*.

Character of the Lower Jaws.—Although the teeth are seen in greater perfection in the smaller species, the other characters of the jaw are best shown by the specimen of *Plag. Becklesii*, Pl. XXXIII. figs. 1 and 4, *a*, *b*, and *b*, *d*. The jaw, right ramus, is broken vertically through one of the sockets of the first true molar; the anterior fragment (*a*, *b*) presents the outer surface of all the teeth in front, from the last premolar, while the posterior fragment (*b*, *d*) exhibits the inner surface of all behind, on to the condyle. A very distinct impression of the premolars attached to the anterior piece is left



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1 Plagiaulax Becklesii 2 6 Plagiaulax minor
7 8 Microlestes antiquus 9 12 Thylacoleo carnifex
13 14 Cheiromys Madagascariensis

on the matrix of the slab which contains the hind fragment, so that it has been easy, by combining the figures, to produce a restored outline of the general contour, which is shown by the aid of dotted lines, in both figures, magnified twice the linear dimensions.[1] The most striking characters are: 1st, the shortness of the jaw from the posterior edge of the ascending ramus to the border of the alveolar sheath of the incisor (*a*); 2nd, the great vertical height of the horizontal ramus in relation to the last dimensions; 3rd, the depressed position of the condyle (*d*), and its great horizontal projection behind the coronoid process. The lower *body* deviates little from the horizontal for about four-fifths of its length, being but slightly convex. The upper margin slopes a little downwards from behind the premolars on to the incisive alveolus, so that if the two margins were produced they would meet at an acute angle. The diasteme is very short. The incisor (*a*) is comparatively large and directed suddenly upwards, the point being elevated above the level of the premolars, with a short bluff sheath-border. The base of the incisor is impressed with a shallow longitudinal fossa, and the upper edge is bevelled. The point shows no mark of abrasion. The mentary foramen is small, indistinct, and situated mesially in a line nearly with the middle of the diasteme. The alveolar border rises in large serrate processes between the fangs. The dark-shaded depression (fig. 4, *i*) behind the vertical fracture (at *b*) upon the matrix marks the position of the pointed gibbosity on the inner side of the alveolus of the last true molar. It is considerably below the line of implantation of the premolars, indicating that the true molars were placed correspondingly low, as is seen in the jaw of the other species. The longitudinal medial shade shows a deeply impressed broad channel upon the outer surface of the ramus, which is most pronounced under and behind the last premolar. The amount of this depression is well exhibited by the vertical sections (Pl. XXXIII. figs. 2 and 3, *f* and *g*), where (*x*) represents the inner surface, and (*y*) the outer. It is seen that the inner surface is slightly concave in the vertical direction, between the upper and lower margins; and that the general convexity of the outer surface is interrupted by a wide and deep fossa, causing a mesial constriction (*y*). Although there is as yet no direct evidence to the point available, in consequence of the outer surface of the posterior portion being adherent to the matrix, still it would appear that this channel runs back towards the

[1] See also fig. 1 of Pl. xxxiv., illustrating a perfect right ramus of a younger individual magnified four times.

depressed disc of the outer surface of the ascending ramus, although it may not have been continuous with it.

The posterior fragment (*b*, *d*, fig. 4, Pl. XXXIII.) shows in very perfect preservation the whole of the inner surface of the ascending ramus and condyle, with the exception of the fragile edge of the inflected lower margin and angle, which are broken off and left in part embedded in the matrix-cast of the opposite slab containing the anterior fragment; it comprises also the posterior portion of the *body*, in which the last molar is implanted. The coronoid process (*e*) is triangular. Its anterior border slopes upwards and backwards to the apex in a gentle curve, at an angle of about 45° with the alveolar border. The posterior margin descends in a curve with little deviation from the vertical into the broad sigmoid notch (*d*, *e*), which is but slightly overarched by the apex.[1] Its height and width at the base are nearly alike, and about equal to the depth of the *body* of the jaw, in a line with the last molar. The apex of the process is sharp. In general form the coronoid process in *Plagiaulax* resembles more that of the predaceous marsupials, and of the Ursine *Dasyurus* especially, than that of the herbivorous families. It differs very markedly from the elevated strap-shaped coronoid of *Hypsiprymnus* and the other herbivorous marsupials. It is to be remarked, however, that it is less elevated, and that its surface is of less area, than in the predaceous genera, whether marsupial or placental.

Fortunately the condyle (*d*, fig. 4, Pl. XXXIII.) is in every respect as perfect as that of a recent bone. The matrix has been removed, so that it stands out in bold relief, showing the convex articular surface entire. In no part of the specimen are the peculiar characters of the fossil more strongly marked than in this process, the remarkable points being: 1st, its very depressed position, the upper edge being below the line of the alveolar border, and the lower extending nearly to the inferior margin of the jaw; 2nd, its prominent convex surface, great depth in proportion to the width, and vertical direction; 3rd, the breadth of the sigmoid notch (*d*, *e*), involving a long neck to the condyle, and its projection much behind the coronoid process. The articular surface is convex and protuberant, narrow in comparison to the height; when viewed endwise, the outline is pyriform, the broad end being uppermost. The general direction of the articular surface is vertical; a chord through the upper and lower edges of the curve would form a very acute angle with a

[1] The artist has represented the posterior margin of the coronoid with too crescentic a curve, and the point projecting too much backward over the sigmoid notch.

perpendicular immediately behind it. The neck-portion of the sigmoid notch (*d*, *e*) is as long as the breadth of the coronoid, so that the articular surface is not only depressed below the apex of the coronoid, but projected a long way behind it. A line drawn from the condyle to the gibbous prominence on the wall of the last molar (*i*) considerably exceeds the length of the horizontal ramus from the latter point on to the border of the incisive alveolus. The inner surface of the ascending ramus behind the orifice of the dentary canal (*n*) is smooth, and near its inferior border traversed by a longitudinal channel which bends back to the under edge of the condyle. The orifice of the canal (*n*) is low and directly in a vertical line with the posterior wall of the last molar, being relatively situated exactly as in *Hypsiprymnus*. The anterior margin of the canal forms a raised step, the edge of which is continued upward in a low crescentic ridge to join on with the base of the gibbous prominence of the last alveolus. The mylo-hyoid groove traverses the ridge about the middle, but the adhesion of the inner surface of the front piece (*a*, *b*) to the matrix does not at present admit of its being determined how far the groove advances upon the horizontal ramus. The inner surface of the coronoid is convex, but this appearance is partly obscured by the plate of the process being traversed by numerous fissures, with partial displacement of the pieces.

The inferior margin of the hind part of the ramus is nearly horizontal; it terminates suddenly in the lower edge of the condyle. A narrow fractured surface (Pl. XXXIII. fig. 4, *o*), the continuation of which was evidently directed inwards (*i.e.* presented to the observer), is seen on the side of the lower edge, stretching from the anterior boundary of the dentary foramen (*n*) on to the condyle. The rest of this inflected margin (what remains of it) is seen embedded in the opposite slab (Pl. XXXIII. fig. 1, *b*, *o'*). It forms a lamina of great tenuity. The base of its inner bounding ridge shows a triangular fracture immediately under the orifice of the dental canal (at *n*, fig. 4, Pl. XXXIII.), where it is comparatively thick; thence the section becomes gradually attenuated on to the condyle. There can be little doubt that this is the characteristic marsupial inflected angle, although feebly developed. It may have formed a slender elongated apophysis, with little inward inflexion, as in *Acrobata*.

The characters of the anterior portion of the inner side of the horizontal ramus, which are concealed by the contact with the matrix in the fragment Pl. XXXIII. fig. 1, *a*, *b*, are beautifully shown by a detached piece lately received from Mr. Beckles, represented by figs. 11–13. It comprises the

anterior third of the ramus, the fracture having passed vertically through the middle of the last premolar. The incisor is broken off near the base of the exserted portion; the two anterior premolars are quite entire, and show well the diagonal grooving on both sides. The alveolar sheath of the incisor is entire all round, and its upper edge presents an exceedingly abbreviated diasteme. The symphysial portion is very short, directed upwards, massive, and obtuse. The disc of the harmonia or junction between the two mandibular pieces is distinctly defined (fig. 12, *b*). It is of comparatively small antero-posterior extent, of a broad elliptical or somewhat reniform outline, with the sinus directed backwards, and the long axis of the disc with but slight deviation from the vertical. The surface is perfectly smooth and without indentation, as is commonly seen in *Hypsiprymnus* and other herbivorous marsupials; while in the carnivorous and insectivorous genera of the same subclass, the symphysial harmonia is narrower and more elongated, with more or less inequality of surface for the reciprocal firm apposition of the united pieces. It is of some importance to take due notice of this character, however trivial it may appear, as every point is of value that can assist us in determining the affinities of this remarkable fossil genus. On the outer surface of this fragment the mentary foramen (fig. 11, *c*) is seen under the middle of the diasteme. It is round, well defined, and of good size. This instructive fragment furnishes direct evidence upon another point of importance, namely, that there was but one large incisor on either side of the lower jaw.

It would have been of great interest and importance to have ascertained the character of the outer surface of the ascending ramus in *Plag. Becklesii*; that is to say, whether, in harmony with the marsupial indications as here interpreted, it presents a depression bounded by a raised ridge sweeping round on the lower side from the condyle to join on with a corresponding ridge descending along the anterior margin of the coronoid; and whether the depression terminated in a trumpet-shaped excavation of the horizontal ramus, common to it and the dentary canal, as occurs in *Hypsiprymnus*. But the fossil is so fragile, that I have not attempted to detach it for fear of injuring what it now exhibits. We may expect, however, if the excavations are continued at Purbeck with the same zeal with which they have hitherto been conducted, that abundant materials will be acquired for clearing up this single unascertained point connected with the characters of the lower jaw of *Plag. Becklesii*. From the direction which the fracture has invariably taken along the line of least resistance, in two fragments on reversed slabs, whenever a

complete jaw has been discovered, and from the circumstance that the inner surface has been always exposed, and the outer remained in adhesion with the matrix, I am led to surmise that this has been caused by the matrix forming a plug in the excavation here referred to, thus causing it to adhere firmly; and I am prepared to expect that the outer surface of the ascending ramus will be found to agree in a great measure with that of the recent *Hypsiprymnus*.

[P.S. Since the preceding remarks were written, a fifth specimen of *Plagiaulax* has been discovered by Mr. Beckles, which supplies the desired information regarding the characters of the outer surface of the ascending ramus. See fig. 1 of Pl. XXXIV. It consists of the left ramus, nearly entire from the incisor to the condyle, showing the whole of the outer surface exposed. The specimen would seem to have belonged to a young individual of *Pl. Becklesii*.

The incisor is vertically inserted, and projects above the level of the premolars, of which there are three. The true molars, if present, are concealed behind the flap formed by the anterior margin of the coronoid process. This part of the jaw has been slightly crushed. The coronoid process rises more vertically, and is narrower than in the specimen, Pl. XXXIII. fig. 4; but a portion of the posterior margin is probably wanting. The base of the coronoid is occupied by a deep depression bounded on the lower side by a raised ridge, which sweeps round from the inferior part of the condyle, to be continued into the anterior margin of the coronoid process. The characters are clearly marsupial; but it is not determinable whether the depression terminates in an excavation of the ramus common to it and the dentary canal, as occurs in *Hypsiprymnus*. So far as can be seen, the depression would seem to be more limited. The matrix has been cleared away from the posterior inner margin, and a portion of the inflected angle is distinctly visible. The specimen, magnified four times linear, is represented by fig. 1 of Pl. XXXIV. It bears out in every respect the marsupial inferences deduced from the other specimens; and indicates for *Plagiaulax* a position between *Hypsiprymnus* and the Phalangers.—*June* 20, 1857. H. F.]

The lower jaw of the other species, *Plagiaulax minor*, is represented by Pl. XXXIV. fig. 2, *a*, *b*, magnified 4 diameters, being double the scale of *Plag. Becklesii*, Pl. XXXIII. figs. 1 & 4. The outer side is exposed, the inner being adherent to the matrix. The notable points are—the shortness of the horizontal ramus from the offset of the coronoid to the border of the incisive alveolus, its great relative height on a line with the premolars (*p m*), and the bold curve of the lower

margin. The incisor (*a*) is projected with a less sudden curve upwards, and its sheath is longer than in *Pl. Becklesii.* The premolars are also larger in proportion to the height of the jaw than in that species. Unluckily the whole of the ascending ramus is wanting, and with it are lost the significant characters yielded by the form of the condyle, coronoid process, and posterior angle. At the fractured posterior end (*b*), a small portion remains of the external oblique ridge which rises into the anterior border of the coronoid. A well-marked wide depression is seen on the posterior part of the horizontal ramus under the true molars, corresponding with that shown on the jaw of *Plagiaulax Becklesii.* In the great development of the premolars, and the dwarfed size of the true molars, there is in the fossil an analogy with *Acrobata pygmæa*, the 'Opossum-mouse,' or 'Pigmy Flying Opossum' of New South Wales. But the resemblance goes no further, the principal premolars in *Acrobata* being much elevated and pointed in front, leaning to the insectivorous type,[1] while they are uniformly compressed, grooved, and serrated in *Plagiaulax minor.*

This concludes what I have to offer in the shape of descriptive details. I shall now proceed to consider what may be legitimately inferred from them respecting the nature and affinities of the fossils. That the genus was mammal admits of no question; that it was a marsupial is inferred for the following reasons, which are given in the order of the directness of the indications:—

1. The compressed hatchet-shaped last premolar with the serrulated edge and parallel grooving. These characters are confined, among all known mammals, to the marsupial genus *Hypsiprymnus*; the correspondence in grooving is so exact that the number of furrows is the same in the fossils and in the recent species with which they were compared, namely, seven; the difference, that they are diagonal in the former and vertical in the latter, being trivial and not typical.

2. The agreement in form, relative size, and direction of the solitary incisor in the fossil rami, with that of the recent *Hypsiprymni.*

3. The indication of the raised and inflected fold of the posterior inner and lower margin of the ramus.

4. The form and characters of the symphysial suture.

5. The absence of any character in the jaw or teeth inconsistent with the marsupial indications.

The presence of only two true molars might seem, at first sight, at variance with a marsupial determination, since it

[1] Waterhouse, Nat. Hist. of Mammalia, vol. i. p. 338.

has been asserted by an able authority, that, with the exception of the edentate 'species of marsupials, or those which are nearly edentate, like the *Tarsipes*, and also excepting the *Myrmecobius*, all *Marsupialia* possess four true molars.'[1] But the character is not absolute, for all the Pigmy-Phalangers of the subgenus *Dromicia*, besides *Acrobata*, are admitted to have only three true molars.[2] In the Purbeck fossils the premolars are inordinately developed, while the true molars are dwarfed and rudimentary in proportion. Where such characters coexist with an exceedingly abbreviated alveolar border, there is less reason for surprise in seeing two of the molars suppressed. It is now well known, that there is no certain distinctive character, whether of placental or marsupial, that can be founded on the number of their teeth. Among the marsupials, *Myrmecobius* presents a case in which they are in excess; while the Purbeck *Plagiaulax* would seem to present the opposite condition, where they are below the normal number, from suppression.

The same reasons are equally strong for referring *Plagiaulax* to the neighbourhood of the existing genus *Hypsiprymnus*. The affinity indicated by the premolars and incisor is so manifest and direct, that details upon the differences from other terms of comparison, placental or marsupial, would be superfluous. The large grooved premolar is confined among the *Marsupilia* to *Hypsiprymnus*; that genus, comprising three subgenera, includes about ten species, in all of which the premolar is solitary, the true molars being constantly four. In *Plagiaulax* there are either three or four grooved premolars, and only two true molars. In *Acrobata* and some of the Phalangers, the inferior premolars are as many as four, the true molars in these instances being reduced to three, a dentary formula which closely approximates that of *Plagiaulax*; while in other Phalangers the premolars are single, the true molars attaining the full complement of four.

In regard to the indications of the true molars, which might, *a priori*, have been expected to be the most significant, the tri-tubercular antepenultimate and the longitudinally two-edged last tooth are without a known analogue among living forms. They certainly bear no resemblance to any insectivorous species, placental or marsupial. The general form of the tubercles of the antepenultimate suggests some resemblance to the omnivorous pachyderms, but it is not sufficiently pronounced to counterbalance the strong leaning of the pre-

[1] Waterhouse, Nat. Hist. of Mammalia, vol. i. p. 8. This generalization was previously stated by Professor Owen, in his memoir in the Zoological Transactions, vol. ii. p. 333, of the 8th Jan. 1839.

[2] Waterhouse, *op. cit.* pp. 307, 337.

molars to a herbivorous regimen. The wear of the two true molars would seem to indicate a grinding, as contradistinguished from a crushing or cutting action of the teeth; and this is confirmed by the form of the articulating surface of the condyle.

The characters of the jaw are so peculiar, and in some respects of so mixed and complex a nature, that they require to be weighed with caution, in conjunction with the teeth, in forming any opinion regarding the affinities of *Plagiaulax*. The low position of the condyle is so pronounced, and the elevation of the coronoid above it so considerable, that regarded *per se*, supposing no teeth had been discovered, they might have been considered to imply with some degree of certainty, a predaceous animal. The condyle is even relatively lower in *Plag. Becklesii* than in *Thylacinus*, *Dasyurus*, and *Didelphys*, the most carnivorous among marsupial forms. A condyle so placed was considered by Cuvier to be a positive indicator of the ferine type. But in *Plag. Becklesii*, the force of the indication is counterbalanced by another character, of which, so far as I am aware, there is no example among any of the predaceous genera, either placental or marsupial, recent or fossil, namely, the long neck and horizontal projection of the condyle behind the coronoid, the term 'neck' being used for convenience to imply the constricted portion of the ramus between the bottom of the sigmoid notch and the lower margin. In all the ferine animals the pivot of motion or transverse condyle is, for obvious mechanical reasons connected with the functions of the jaw, brought on a short stem close under the base of the coronoid process. In *Plagiaulax* it is carried out upon a long pedicle behind, and, *pro tanto*, there is a great deviation from the predaceous type. The arrangement is equally without a parallel among the herbivorous or omnivorous types, in which the condyle is ordinarily elevated above the horizontal plane of the teeth, with more or less freedom of lateral or longitudinal motion. Further, the convex articular surface of the condyle, and its vertical instead of transverse direction, are at variance with the locked implantation of the jaw of a ferine animal. The other leading indications all lean towards a vegetable feeder, namely, the limited surface and moderate elevation of the coronoid above the plane of the teeth; the feeble development of the inflected margin, and the absence of a thick angular process; the advanced position of the orifice of the dentary canal; the offset of the inflected margin above it, and the form of the symphysial suture. These characters, taken in conjunction with the marked signification of the teeth, would seem clearly to place *Plag. Becklesii* among the

vegetable feeders. In this view, the exceptional position of the condyle would be regarded as a special modification, having reference to the abnormal character of the teeth, and the adjustment involved thereby, *i.e.* the excessive development of the premolars, and the suppression of so large a portion of the true molars, together with the functional degradation of the two which remain.

Giving due weight to these various considerations, and with the above-indicated analogy in the dental formula to guide us, I am led to the conclusion that *Plagiaulax* may be regarded in the natural system as a marsupial form of rodent, constituting a peculiar type of the family to which *Hypsiprymnus* belongs, and as bearing, in respect of number of teeth, the kind of relation to that genus which *Dromicia* bears to the other Phalangers, and *Acrobata* to *Petaurista*. Mr. Waterhouse includes the Kangaroo rats among the *Macropodidæ*: *Plagiaulax* could never be classed among the Kangaroos. But, although inferred to have been allied to *Hypsiprymnus*, the fossils were generically widely distinct from the existing Kangaroo rats. A great many links of the chain which would place them in connection are unknown to us, some of which may yet turn up in the fossil state.

The species of *Plagiaulax* must have presented a form of which there is nothing to remind us among living marsupials. This is indicated by the extreme shortening, compression, and depth of the lower jaw, together with the sudden upward curve of the incisor, and still more by the depressed position and backward projection of the condyle. For aught that we know to the contrary, they may have had the volant habits of the Flying Phalangers, and flitted from tree to tree among the oolite forests by means of parachute-folds of their skin. As the Kangaroo rats are strictly herbivorous, gnawing scratched-up roots, it may be inferred of *Plagiaulax* that the species were herbivorous or frugivorous. I can see nothing in the character of their teeth to indicate that they were either insectivorous or omnivorous.

The larger species, *Pl. Becklesii*, I have named after Mr. Beckles, the discoverer, to whose energetic and well-considered explorations Palæontology is indebted for so many and important additions to the Upper Oolite (Purbeck) fauna, after the efforts of the Geological Survey Department, specially directed to the same object, under so able a head as the late Professor E. Forbes, had proved unsuccessful. This species equalled the size of a squirrel, or nearly that of *Petaurus macrourus*,[1] one of the Flying Phalangers. The other species

[1] The skeleton so named in the Cat. (Osteol. Mus.) Roy. Coll. Surgs., No 1849.

was very much smaller, and, being one-half the linear dimensions, was probably about one-twelfth of the bulk of the former, or near the size of the 'Pigmy Flying Opossum,' *Acrobata pygmæa*.

About the mammalian associates of *Plagiaulax* I abstain from making any remarks beyond the few which are introductory to this paper, as the fossils will so soon pass, for a detailed description, into the hands of Professor Owen, who has already designated one of the largest of the new forms by the generic name of *Triconodon*. The Purbeck mammalian genera announced up to the present date are, therefore, *Spalacotherium*, *Triconodon*, and *Plagiaulax*.

There are, however, some points of general geological interest, on which I may be permitted to make a few observations.

The first is the relation of resemblance which the molar teeth of *Plagiaulax minor* bear to those of the Triassic *Microlestes antiquus* of Plieninger. The agreement in general form is so close, that, had detached molars of both been met with in beds of the same formation, they might have been taken for back and front, or upper and lower teeth of the same, or of nearly allied, species. The essential crown-characters are the same in both, namely, two opposed longitudinal marginal ridges, more or less lobed or crenated, and separated by an intermediate chasm or depressed disc.[1] A solution, however approximative, of so ancient and obscure a mammal as *Microlestes* is not devoid of interest. Plieninger considered it to be predaceous, hence the name; other naturalists were disposed to regard it as leaning, however remotely, to the omnivorous Pachyderms, or omnivorous Insectivora; while Professor Owen, in recognizing at once the mammalian character of the teeth, admitted them to be distinct from anything fossil or recent known to him.[2] Pictet, in his 'Paléontologie,' doubtingly includes *Microlestes* among marsupials, for reasons which he does not state, upon the authority of some of the German describers, whose memoirs I have not been able to consult. Bronn notices *Microlestes* in

[1] Judging from the very careful drawings and casts, the two teeth of *Microlestes*, figured in Lyell's 'Manual of Geology,' would appear, as there surmised, to indicate at least distinct species. The larger tooth (fig. 442, p. 343 of that work) resembles the penultimate molar of *Plagiaulax Becklesii*, regarded in the side-aspect, inner surface. There is in both an anterior talon, forming an accessory lobule where it joins on with the anterior inner tubercle. But I can detect nothing in either like the basal cingulum referred to by Mr. Waterhouse (*loc. cit.*). Fig. 441, representing the first discovered tooth of *Microlestes antiquus*, crown aspect, is the one which bears the closest resemblance to the last true molar of *Plagiaulax minor*.

[2] Cited in Lyell's Manual, 5th edition, p. 343.

the 'Lethæa Geognostica,' as being probably a predaceous marsupial (3rd edit. vol. ii. p. 122).

The next point to which I would solicit attention is, that *Plagiaulax* would seem in some respects to furnish a crucial test of the soundness of certain generalizations which have been put forward regarding the order of successive appearance of mammalia upon the surface of the earth. It has been maintained by British palæontologists and comparative physiologists[1] of the highest authority, that, while there is no good proof of a serial progressive development from the lower to the higher forms, there is evidence of another order of development or successive passage, namely, from the *general* to the *special*, as we descend from the oldest to the modern period. It is urged by the advocates of this doctrine, that the Mammalia of the Eocene period assimilated more to the general plan of the archetype and to the embryonic condition of the vertebrate organization; while the Mammalia of modern times successively furnish more and more numerous examples of deviation from the archetype, all tending towards special adaptation. Among other arguments, they insist that the earliest Eocene Mammalia, both carnivorous and herbivorous, possessed, in most cases, the full complement of teeth; while forms characteristic of later times, such as the *Felidæ* and *Ruminantia*, are remarkable for special suppression of these organs. If the generalization were really of as wide an application as has been claimed for it, we ought to find evidence of closer adherence to the general archetypic model the further back we recede in time. But so far is *Plagiaulax*, at present the oldest well-ascertained herbivorous mammal yet discovered, from giving any countenance to the doctrine, that it actually presents the most specialized exception, so to speak, from the rule, to be met with in the whole range of the Marsupialia, fossil or recent. It had the smallest number of true molars of any known genus in that subclass, six at least of the normal number of incisors being also suppressed; thus exhibiting, at the most remote end of the chain, the very characters which, under

[1] Carpenter, Principles of Compar. Physiology, 4th edit. 1854, pp. 107–111. The doctrine here referred to is developed in considerable detail by Dr. Carpenter in the passage above indicated. In a note (*loc. cit.* p. 111) he disclaims it as having originated with himself: 'The principle expounded in this paragraph has been prominently enunciated and illustrated by Professor Owen in various parts of his writings. The remarkable facts here stated with respect to the dentition of mammalia are contained in his article "Teeth," in the Cyclopædia of Anatomy and Physiology, vol. iv.' Some interesting illustrations bearing upon the retention of the typical formula of dentition in the placental mammals of the Eocene and Miocene periods, and upon the departure from it in modern mammals, are adduced by Professor Owen in his memoir 'On the Dentition of Phacochœrus,' Phil. Trans. for 1850, p. 495.—H. F., *June* 20, 1857.

the generalization in question, we might *a priori* have expected to encounter at the near end among existing marsupials.

The curious fact, that only lower jaws should have turned up among the Stonesfield mammalian remains has often been the subject of speculation or remark. The same, to a certain extent, has held good with the remains found in the Purbeck beds. Among the determined fossils, lower jaws predominate largely. But some upper maxillaries have been met with, and, while writing, I have received intimation of the discovery of more. Among the undetermined remains there is a considerable number of other bones of small animals, many of them probably mammals, but they are seldom or ever perfect. In these minute creatures, unless the bone be complete, and, supposing it to be a long bone, with both its articular surfaces perfect, it is almost hopeless, or at any rate very discouraging, to attempt to make out the creature which yielded it; whereas the smallest fragment of a jaw with a minute tooth in it, speaks volumes of evidence at the first glance. This I believe to be one great reason why we hear so much of jaw-remains, and so little of the other bones. For, as an inferior maxillary is to the other bones of the skeleton in the ratio of about 1 to 250, *cæteris paribus*, a large number of these should be encountered for every lower jaw that turns up. No indication has yet been met with at Purbeck of the bone of a good-sized terrestrial mammal. But I do not consider the negative evidence in this case to be decisive of their non-existence. The matrix of the so-called 'Dirt-bed, No. 93,' by which most of the mammal remains have been yielded, is a whitish-grey, fine-grained marl, full of the exuviæ of freshwater animals, hardening into a kind of stone when the moisture is expelled by desiccation, but very bibulous, and readily becoming pasty, after immersion in water. It has properly no claim to the designation of a 'dirt-bed,' or 'ancient vegetable soil,' as there is rarely a speck of vegetable matter to be seen in the numerous specimens containing bone-remains which have passed through my hands.[1] It appears to me to present more the character of the deposit near the margin of a patch of fresh water, and that the probable explanation of the association of so many small bones of minute mammals and lizards is that they were the floating objects most readily drifted to the margin by a surface-ripple from wind, or by a wave-eddy. In India, in

[1] I am informed by the Assistant-Secretary of the Geological Society, however, that the hand-specimens of this bed, in which *Spalacotherium* occurred in 1854, were of a dark colour and contained vegetable remains, together with freshwater shells. See Quart. Journ. Geol. Soc. vol. x. p. 423.

the tanks, or wherever running water falls into an artificial lake, numerous remains may be observed, along the margin, of the bones of frogs, lizards, mice, and musk rats, forming a more or less continuous edging, without the admixture of large bones, which lie in abundance below the deeper water. The former float and are drifted to the margin by the action of the wind, and rest there.

M. Lartet pointed out to me, in the rich Falunian deposit of Scissan, certain parts of the Lacustrine bed where skeletons of large terrestrial animals, such as Mastodon and Rhinoceros, are more or less abundant; while in other situations near the margin immense quantities occur of the bones of small animals, such as frogs, lizards, shrews, and minute rodents, which may be taken up by the handful unmixed with larger bones. The mammaliferous band, 'No. 93,' where most productive, does not exceed five inches in thickness. If the excavations could be carried into a line of section where the bed is thicker, it does not seem too much to hope that they might be rewarded by the discovery of larger mammals, when we consider the numerous acquisitions to Palæontology which have been made within the last two months alone from Purbeck, and the improbability that a fauna already proved to have been so extensive should have been restricted to small creatures only. Further, where herbivorous mammals are shown to have existed, it would seem in the highest degree improbable that they should have been limited to a single genus containing two small species like *Plagiaulax*.

VIII. ON THE DISPUTED AFFINITY OF THE MAMMALIAN GENUS PLAGIAULAX, FROM THE PURBECK BEDS.[1]

One of the most accurate observers and original thinkers of our time has discoursed with emphatic eloquence on the imperfection of the geological record.[2] Besides what is yet to be discovered, so much has been irrecoverably lost that we may never hope to write more than disconnected pages of the palæo-biography of nature. The truth of the assertion comes home to the conviction of all; but so far from discouraging, it only renders us the more eager to pursue what we may attain. Every now and then, in palæontology, an unknown form is discovered of so unexpected a character that our habitual train of ideas is diverted by it into a new avenue of thought. It may confirm a position which has before been merely conjectural, or but faintly shadowed out; or it may shake the foundations of some cherished, but unsound, hypothesis. It is hailed with more especial satisfaction if it contribute to fill up any of the great gaps in our existing knowledge. The form itself is often presented to the first observer in such a mutilated or imperfect aspect, that at the best he can effect little beyond an approximative idea of the outline. From the same cause, or from a balanced conjunction of unusual characters, he may fail in his first attempt at the interpretation; but he has no reason to be ashamed of the failure, if he has devoted his powers fairly to the investigation; for a great part of the solid progress made in science is mainly effected by the later observer correcting the errors of those who have preceded him. Reproach can only be felt when we allow some bias unduly to influence our interpretation—when we strain facts to countenance a particular view. If the observer has guarded himself against this weakness, and with care used the proper means of investigation, whatever opposition his results may at first encounter, generally speaking, he may be at ease, in the

[1] This paper was communicated to the Geological Society of London on June 4, 1862, and is reprinted from the 'Quarterly Journal of the Society' for November, 1862. The illustrations have been reproduced on stone from the original woodcuts.—[Ed.]

[2] Darwin, 'On the Origin of Species,' p. 287.

assurance, that further research and future discovery will only confirm and extend them. If the conclusions are challenged, science is invariably benefited by the controversy. Different modes of analysis and different trains of ideas are brought into conflict; and landmarks are established for the warning and guidance of future observers.

Among the mammalian forms brought to light through Mr. Beckles's important researches in the Purbeck Beds, there was one which struck me with especial interest. I found in it a singular combination of characters:—The dentition modified by suppression to as great an extent as in any existing form; strong analogies, in some respects, with known genera, while in others it diverged from them very widely. Early in 1857 I communicated to the Geological Society an account of the genus *Plagiaulax*, which appeared in the 13th volume of the 'Quarterly Journal' (p. 261 [1]). About the same time an abridged description of the form, illustrated by figures, was brought out in the Supplement to the 5th edition of Sir Charles Lyell's 'Manual of Geology' (1857, p. 17). On both occasions I arrived at the conclusion that '*Plagiaulax* may be regarded in the natural system as a Marsupial form of Rodent,[2] constituting a peculiar type of the family to which *Hypsiprymnus* belongs,' although widely distinct from that genus.

The only comment impugning this determination that has come under my notice, appeared in the Article 'Palæontology,' by Professor Owen, in the 8th edition of the 'Encyclopædia Britannica,[3] published in January, 1859, and subsequently reproduced as a separate work.[4] The two accounts differ in some unimportant particulars. I here cite the later in date, as presumably conveying the latest views of the author. The following are extracts:—

'Two specimens exemplified the shape and proportions of the entire jaw of this species (*Plagiaulax Becklesii*). The foremost tooth is a very large one, shaped like a canine, but implanted by a thick root in the fore part of the jaw, like the large lower incisor of a Shrew or Wombat. The three anterior teeth in place have compressed trenchant crowns, and rapidly augment in size from the first to the third.

[1] See *antea*, p. 408.—[Ed.]

[2] I leave the words as they originally stood; but my meaning would have been more accurately conveyed by the expression 'Rodent type of Marsupial,' —rodent being here used in the large sense, having reference to the plan of dentition, characterized by two collateral incisors in the lower jaw, as typically shown in the placental series by the *Rodentia* and *Cheiromys*; and in the *Marsupialia*, by *Phascolomys*, modified in the *Macropodidæ* and the *Phalangistidæ* by the opposition, in the upper jaw, of several incisors. (See Cuvier, Oss. Foss. 4th edit. tom. v. p. 3.)

[3] Vol. xvii. p. 161.

[4] Palæontology, 2nd edit. p. 353.

They are followed by sockets of two much smaller teeth, shown in other specimens to have subtuberculate crowns resembling those of *Microlestes*. The large front tooth of *Plagiaulax* is formed to pierce, retain, and kill; the succeeding teeth, like the carnassials of *Carnivora*, are, like the blades of shears, adapted to cut and divide soft substances, such as flesh. As in *Carnivora*, also, these sectorial teeth are succeeded by a few small tubercular ones. The jaw conforms to this character of the dentition. It is short in proportion to its depth, and consequently robust, sending up a broad and high coronoid process, for the adequate grasp of a large temporal muscle; and the condyle is placed below the level of the grinding teeth—a character unknown in any herbivorous or mixed-feeding Mammal: it is pedunculate, as in the predaceous *Marsupialia*, whilst the lever of the coronoid process is made the stronger by the condyle being carried further back from it than in any known carnivorous or herbivorous animal. The angle of the jaw makes no projection below the condyle, but is slightly bent inward, according to the Marsupial type.'

'In the general shape and proportions of the large premolars and succeeding molars, *Plagiaulax* most resembles *Thylacoleo* (fig. 178, p.m. 1 and 2), a much larger extinct predaceous Marsupial from tertiary beds in Australia. But the sectorial teeth in *Plagiaulax* are more deeply grooved; whence its name. The single compressed premolar of the Kangaroo Rat is also grooved; but it is differently shaped, and is succeeded by four square-crowned, double-ridged grinders, adapted for vegetable food; and the position of the condyle, the slenderness of the coronoid, and other characters of the lower jaw are in conformity to that regimen. In *Thylacoleo* the lower canine or canine-shaped incisor projected from the fore part of the jaw, close to the symphysis, and the corresponding tooth in *Plagiaulax* more closely resembles it in shape and direction than it does the procumbent incisor of *Hypsiprymnus*. From this genus *Plagiaulax* differs by the obliquity of the grooves on its premolars; by having only two true molars in each ramus of the jaw, instead of four; by the salient angle which the surfaces of the molar and premolar teeth form, instead of presenting a uniform level line; by the broader, higher, and more vertical coronoid; and by the very low position of the articular condyle.

'The physiological deductions from the above-described characteristics of the lower jaw and teeth of *Plagiaulax* are, that it was a carnivorous Marsupial. It probably found its prey in the contemporary small insectivorous Mammals and

Lizards, supposing no herbivorous form, like *Stereognathus*, to have co-existed during the Upper Oolitic period.'[1]

We have here an opinion, professing to be founded on the high ground of a connected series of physiological correlations, that *Plagiaulax* was a carnivorous Marsupial; while the same materials led me to infer that it was phytophagous. These diametrically opposed inferences recall, in some degree, the discussion, famous in its day, respecting the disputed affinities of *Amphitherium.* The question then was, whether the fossil was mammal or reptile; and the foundations of Palæontology were supposed to be concerned in the issue. In the present instance the area of the field of difference is less, but the interests involved are still important. Are the indications of palæontology, more especially in its great stronghold in the Mammalia—the teeth and correlated organs—so unstable or so obscure, that of two palæontologists, the same dental and mandibular materials shall lead the one to infer that the fossil form was a vegetable feeder, and the other that it was a predaceous carnivore? Or does this conflict of opinion arise from different methods having been followed by the observers in dealing with the evidence?

As the Geological Society gave to my original communication a place in its Journal, I feel bound, in the interest of science, either to support the opinion which I then advanced, or frankly to admit the correction, if I am found to be in error. I am further impelled by my sense of self-respect, as an observer, to consider whether—apart from the conclusions—I have fallen into such errors of observation and description as would necessarily be implied, should Professor Owen's manner of viewing the objects prove correct; and if so, to explain the fallacious train of reasoning which led me astray; for I cannot plead the excuse that the account was written in haste, or without due consideration.

If the data, upon which the author of 'Palæontology' professes to rest his physiological deductions, were sound, the demonstration would be complete. They are put together with an exemplary show of harmony, and, with a single exception, every link in the chain is supplied. But there are, in the case, considerations of paramount import in an argument of this nature, that lead me to question their soundness, and to dissent from the conclusions.

And first, as regards the admitted facts. Professor Owen agrees that the Purbeck remains establish two species of *Plagiaulax*; and as he has adopted two of the woodcuts given in my original description of these species, it is pre-

[1] Palæontology, p. 353. I entertain strong doubts about the soundness of the deduction which makes *Stereognathus* to have been herbivorous.

sumed that the correctness of the figures is not questioned. The marsupial nature of the forms is not disputed, nor is there any difference of opinion about the number or designation of the teeth.

In both species there is a solitary incisor on each side of the lower jaw, in the fore part of the incisive border, closely followed, without the interposition of a canine, by a series either of three or of four premolars. The rami converge to a narrow point in front, so that the tooth occupies the entire width of the incisive border on each side; and fig. 13, p. 280, of my former communication,[1] representing the symphysial portion endwise, shows (what is confirmed by the other figures) that the two incisors were approximated and collateral, as in the rodent type, placental or marsupial. In *P. minor* (Pl. XXXIV. fig. 2), the tooth is procumbent. In the other and larger species, *P. Becklesii*, it is more robust, with a thicker root, and with a more decided curvature upwards, suggesting, at the first sight, some resemblance to the form of a canine. In both species the point is bevelled;[2] and I failed to observe in either any mark of the play of an opposed upper tooth.

What was the function of these incisors? Professor Owen's opinion is expressed thus: 'The large front tooth of *Plagiaulax* is formed to pierce, retain, and kill.' This conclusion arrived at, the other characters are naturally regarded in unison with it, until the genus is finally presented to us as a predaceous carnivore. It is therefore necessary to examine the evidence closely. Now, in solving a question of this kind, comparative anatomy supplies for our guidance fundamental principles, which govern the interpretation of mere form. Let us revert to the known marsupial genera, and see what light generalized observation upon them throws upon the question. In all the Carnivorous genera and species, fossil or recent, of which the dentition has been accurately determined, there are three or more incisors, followed by a canine, on each side of the jaw, above and below; and the empirically observed result is consistent with a rational interpretation of the arrangement, in reference to their food and the means of procuring it. On the other hand, in all the existing strictly phytophagous genera, there is only a solitary incisor (being that next the axis) on either side of the lower jaw, and no canine; or if, as among the Phalangers, additional teeth are developed, the *outer* incisors and canine are

[1] Pl. xxxiii. fig 13 of this volume.—[Ed.]

[2] Not in the sense of being denuded of enamel by wear, but the posterior surface is flattened near the apex, so as to yield a slightly bevelled point. (See *antea*, p. 417.)

alike rudimentary. The pair of developed incisors are approximated and placed collaterally, as in the placental Rodents; and commonly they are projected forwards with but a very slight upward inclination. They are unequally opposed in the upper jaw by two or more incisors on either side. Why there should be this plurality of incisors above, and only two invariably occupying the same position below, is wholly unknown to us; but the constancy of the structure makes it certain that there must be a sufficient cause for it in nature; and we employ the generalization, empirically arrived at, with as much confidence as we do the law of necessary correlation.[1] In many critical cases, where the evidence is limited or defective, the empirical is even a safer guide than the rational law, since it is freer from the risk of errors of interpretation. Applied to the instance before us, it is manifest that the principle on which the incisors in *Plagiaulax* are framed, in regard of number, order of suppression, collateral position, and relation to the premolars, corresponds exactly with the type of the Marsupial Herbivores, such as *Halmaturus*, *Hypsiprymnus*, and *Phascolarctus*, and that it is wholly at variance with the Carnivorous type.

Let us now test the opinion in its professed character as a physiological deduction. Throughout the *Mammalia*, where teeth perform the functions of canines 'to pierce, retain, and kill,' they are held well apart through the interposition of a line of incisors—the end being obvious; the points of penetration are doubled, the grasp is strengthened by widening the base, and the dilacerating and killing powers are multiplied. To arrange them collaterally in the axis would be to place them at a disadvantage to the end to be attained. But when a gnawing power is required, the middle incisors are powerfully developed, and placed collaterally in the axis of the jaws, one on each side, above and below, as typically exemplified in the placental Rodents and *Cheiromys*. Doubtless a Rat when seized can inflict a smart wound on the hand; but the power is a secondary attribute, complementary to the main function. Regarded in this aspect, it is negatively stamped upon the incisors of *Plagiaulax* by their collateral position, that they are not constructed upon the carnivorous plan of design, nor in rational correlation thereto.

It is obvious that this position of the teeth in *Plagiaulax* was not overlooked by the author of 'Palæontology'; for, on the first occasion he describes the incisor of *P. Becklesii* as being 'very large, shaped like a canine, but implanted by a

[1] Cuvier, 'Discours Préliminaire,' p 51.

thick root in the fore-part of the jaw, like the large lower incisor of a Kangaroo[1] or Wombat.' But the shape of the tooth prevailed in deciding him to pronounce it carnivorous. Now, the form differs in the two species; and I ask any Comparative Anatomist to look at fig. 2 of Pl. XXXIV., and say whether the tooth there represented is formed to pierce, retain, and kill—being the attributes with which Professor Owen invests the incisor of *P. Becklesii*. It is projected forwards with a slight upward inclination, somewhat as in the vegetable-feeding Koala (*Phascolarctus cinereus*). The incisor of *P. Becklesii*[2] is undoubtedly curved more decidedly upward; and, when viewed sidewise, it is not very unlike a canine. But the same may be said equally of the lower incisor of the Lemurine Aye-Aye (Pl. XXXIV. figs. 13 and 14). In this remarkable form, the affinities of which were so keenly disputed by the great French anatomists, Cuvier and De Blainville, the solitary incisors are collateral, on the Rodent type; compressed laterally, and very deep at the base, they sweep upwards in a bold curve, being scooped vertically behind, to terminate in a sharp edge; so that, regarded sidewise, so far as vertical direction goes, they are more canine-like than in either species of *Plagiaulax*. But the resemblance goes no further. In the former the incisor, which is only partially invested with enamel, is continued backwards below the molars, the pulp-nucleus being persistent, and the chisel-shaped edge is constantly maintained by use[3]—conditions which are wanting in the latter. Should the construction of the skull and other parts of the skeleton of *P. Becklesii* be ever discovered, there is little doubt that modifications will be detected throughout in conformity with those of its incisors, as in the felicitous instance, cited by Cuvier, of the secret relation between the upper canine-shaped incisors of the Camel and the bones of the tarsus; this exceptional character does not remove the Camel from among the Ruminants, nor does the form of the incisor of *P. Becklesii* appear to me to be of sufficient weight to counterbalance the clear evidence of a phytophagous and rodent plan of construction.

[1] Encyclop Brit 8th edit vol xvii. p 161 'Shrew and Wombat' are substituted in the 'Palæontology,' p 353.

[2] Pl. xxxiii fig 1.

[3] De Blainville asserts that the incisors of the Aye Aye are invested all round with a shell of enamel, and that the posterior facet is not the result of wear (Mémoire sur l'Aye-Aye, p 23); while Dr. Sandwith, in his interesting account of the habits of this animal, affirms that the facet is denuded, as in the Rodents (Zool Proc Feb 22, 1859, p 111). In a finely preserved cranium, for the transmission of which to London I am indebted to the great courtesy of M Édouard Verreaux of Paris, it is distinctly seen that the coat of enamel is limited to a belt which sheathes only the anterior half of the incisors.

Professor Owen draws an argument, in confirmation of his view, from the dentition of *Thylacoleo*. The statement is:—'In *Thylacoleo* the lower canine, or canine-shaped incisor, projected from the fore-part of the jaw, close to the symphysis; and the corresponding tooth in *Plagiaulax* more closely resembles it in shape and direction than it does the procumbent incisor of *Hypsiprymnus*.'[1] But on referring to his detailed description of *Thylacoleo*, we find that the body of the tooth, of which the shape and direction are adduced as terms of comparison, together with the fore part of the symphysis and incisive border, is wanting[2]:—'The symphysis (Pl. XIII. fig. 4, *s*) begins behind, at a vertical line dropped from a little in advance of the middle of the sectorial, *p* 4; it is of a wide and oval form. To judge from the cast, but little of the jaw appears to have been broken away from the fore-part of the symphysis. The upper and fore-part shows the alveolus and base of a tooth (Pl. XI. fig. 3, *c*) which has projected obliquely upward and forward. It is separated by an interspace of three lines from the sectorial, and would seem to be the sole tooth in advance of it. If the ramus be really produced at the upper part of the symphysis further than is indicated by the present cast, *it may have contained one or more incisors, and the broken tooth in question may be the lower canine*. If, however, this be really the foremost tooth of the jaw, it would appear to be one of a pair of large incisors, according to the Marsupial type exhibited by the *Macropodida* and *Phalangistida*.'[3] 'But in the lower jaw the carnassial is succeeded by two very small tubercular teeth, as in *Plagiaulax*; and there is a socket close to the symphysis of the lower jaw of *Thylacoleo*, which indicates that the canine may have terminated the dental series there, and afforded an additional feature of resemblance to the *Plagiaulax*.'[4]

In all this, it will be seen, the argument is within the domain of conjecture; the tooth oscillates between canine and incisor; and not merely so, but the principles which are followed as guides in this walk of investigation are set aside, to give place to the illusory indications of mutilated external form. If the tooth represented by a stump or socket proves to be a canine, the comparison will not hold; but if it be solitary with the position of an incisor, will it even then bear out Professor Owen's hypothesis, that *Thylacoleo*, which he

[1] Palæontology, p. 353.

[2] 'Unfortunately this morceau is much mutilated, the incisor being broken at its entrance into the alveolus, its form cannot therefore be precisely given; but it is evident that it was curved upwards'—Stutchbury, Report on the Discovery of Gold in Australia, 1855, p 53

[3] Phil. Trans, vol cxlix p 318.

[4] Palæontology, p 432.

infers to have been one of 'the fellest and most destructive of predatory beasts,' [1] may have had the laniary portion of its teeth in its lower jaw constructed on the type of the most meek and defenceless of herbivorous marsupials? Bearing in mind the sense in which the term 'type' is accepted among naturalists, I must avow that I have some difficulty in realizing the conception. But should the unusual conjunction of characters assumed above be hereafter established, there are theoretical considerations which would prove to demonstration that the types of construction are still absolutely distinct. For in the supposed case the outermost incisor would be the one developed, the inner ones being suppressed; while, conversely, in the *Macropodidæ* it is the *innermost* incisor which is developed, the outer ones being suppressed. Morphologically, therefore, the types of construction would be radically different. If palæontological investigations were conducted in this manner, there would be no limit to conjecture; the landmarks which we profess to follow would be disregarded, and disorder would face us everywhere. But, happily, science furnishes unerring principles which provide the corrective. I need hardly add that the argument drawn from *Thylacoleo* has, in my view, no bearing on the incisors of *Plagiaulax*, and gives no support to the carnivorous inference.

Next, as regards the premolars. From their peculiar characters and remarkable development, they furnish the most striking features in the dentition of the fossil genus. In *P. Becklesii* there are three, and in *P. minor*, four of these teeth, which diminish rapidly in size from the last to the first.[2] I here take the last as the most determinate in form, and in its nature the most constant. I compared it rigorously with the corresponding tooth of *Hypsiprymnus Gaimardi*, and I affirm now, as I did in my original paper, that these homologous teeth, in the two genera, are identical in every essential point of form and construction. In proof, I refer to figures 5 and 6 of the representations in Pl. XXXIII., the former showing the last premolar of *Plagiaulax*, the latter of *Hypsiprymnus*. The resemblance is so manifest and direct, that I never contemplated that it could be called in question; but, as it has been questioned, it is necessary to descend to particulars. In both, the crown viewed from the side is of a quadrately oblong form, the length exceeding the height; in both, it is compressed and trenchant, the sides sloping uniformly from the base to a thin edge like a wedge; in both, the basal part of the tooth presents a smooth sur-

[1] Phil. Trans., vol. cxlix. p 319.
[2] See Pl. xxxiii and xxxiv.—[Ed.]

face, above which the crown is traversed by a series of close-set, uniform, and exquisitely defined parallel grooves, sharply angular, and bounded by linear ridges; in both, these grooves occupy both sides of the tooth; and in both, the channelled sides meet in a finely serrated edge. Not the least remarkable point in this striking list of agreements is the curious numerical coincidence—these grooves being developed seven in number, alike in the homologous premolars of *Pl. Becklesii* and of *Hypsiprymnus Gaimardi*.

As to the points of difference: in *Plagiaulax* there are three or four of these teeth, while in *Hypsiprymnus* there is but one; in the former they are presented with the *maximum* of development, in the latter with the *minimum*; in the former the grooves are diagonal, in the latter vertical. With this exception, and with some trivial details of difference in the proportion of the length of crown to its height, and in the amount of the basal surface free from grooving, the last premolar in *Hypsiprymnus* is identical in its characters with that of *Plagiaulax*. The two convey to my mind the impression of being typically alike.

The objects strike Professor Owen in a very different light. His statement is that, 'in the general shape and proportions of the large premolar and succeeding molars, *Plagiaulax* most resembles *Thylacoleo*, a much larger predaceous marsupial, from the tertiary beds in Australia. But the sectorial teeth in *Plagiaulax* are more deeply grooved; whence its name. The single compressed premolar of the Kangaroo Rat is also grooved; but it is differently shaped,' &c. Now, apart from the inferences, here is a conflict of description, which can be settled by an appeal to the original specimens I have described the large premolar as essentially alike in form, in the Kangaroo Rat and in *Plagiaulax*. Professor Owen states that it is differently shaped in the two; if so, I invite him to show wherein the difference consists (I have failed to detect, and he as yet to indicate it)—bearing in mind that here it is not a question of slight difference, such as a modification in the outline of the same organ in two nearly allied forms, but a difference of type—or of ordinal importance.

Next as regards the assertion that in the general shape the large premolar of *Plagiaulax* most resembles *Thylacoleo*. For convenience, I separate the two terms of the comparison in the sentence. Professor Owen has figured and described the sectorial teeth of this large Marsupial, in his late memoir on the 'Fossil Mammalia of Australia.'[1] In *Thylacoleo* the

[1] Phil. Trans., vol. cxlix. p. 318, Pls. xi. and xiii.

inferior premolars are reduced to a single, but enormously large and massive, carnassial, with two small tubercular teeth behind it. The carnassial (Plate XXXIV. figs. 9—12) consists of a long blade, high in front and lower behind, so that, if notched in the middle, the divisions would in some degree resemble the anterior and posterior lobes of the corresponding tooth in the placental Carnivora;[1] and the worn summit is distinctly concave lengthwise; conversely, in both species of *Plagiaulax* the corresponding tooth is convex, and the outline of the whole series describes a convex curve, of which the last premolar forms the most salient part. The base of the carnassial in *Thylacoleo* is 'slightly grooved vertically' on the inside (fig. 9). These indentations disappear about half-way up towards the edge, where the surface becomes reticulately rugose, being precisely the reverse of what occurs in the last premolar of *Hypsiprymnus* and *Plagiaulax*. Besides the difference of their position upon the teeth, the grooves of the carnassial of *Thylacoleo* present the appearance of furrows, separating superficial undulations of the enamel. A transverse section of the basal part of the crown would yield a faintly crenated outline, wholly different from the salient and re-entering angles of the close-set parallel grooves of *Plagiaulax* and *Hypsiprymnus*. These undulations are exhibited chiefly, if not solely, on the inner side; their presence on the outer is not mentioned. Further, if the indentations on the premolar of *Thylacoleo* are to count for anything as significant of affinity, it should be with *Hypsiprymnus* rather than with *Plagiaulax*, since the furrows are vertical in the two former. In fact, in the outline and proportions of the vertical section, the premolar of *Thylacoleo* differs less from *Hypsiprymnus* than it does from that of *Plagiaulax*. I have failed to realize the asserted resemblance between *Plagiaulax* and *Thylacoleo* in the form of the last premolars; and in the details of outline, section, curvature of edge, crenulation, surface-markings, &c., I am more impressed with the differences than with any one point of agreement.

Let us now consider the inference as to the function of these teeth. It is expressed thus:—'The large front tooth is formed to pierce, retain, and kill; the succeeding teeth are like the blades of shears, adapted to cut and divide soft substances like flesh,' &c. Professor Owen has elsewhere described the premolar of *Hypsiprymnus* as trenchant,[2] and I have shown above that the tooth is essentially alike in

[1] 'The first molar is lunate, the cusps turning inwards, and the anterior cusp rising at a salient angle, the edge is trenchant outwards, the second molar is triangular with a large anterior cusp, and a slight ridge passing to a small depressed posterior cusp.'—Stutchbury, *loc cit.*

[2] Odontography, vol. i. p. 389.

Plagiaulax. If, therefore, the function is to be deduced with such facile certainty from the mere form, the premolar of *Hypsiprymnus* ought also to be carnivorous. But we know that the genus is so strictly herbivorous that the family to which it belongs has been regarded as representing in the *Marsupialia* the Ruminants of the Placental Mammals. With this fact before us, is it likely that the premolars of *Plagiaulax* were applied to cut and divide flesh? Does the serrated edge indicate a flesh-cutting function? The singular agreement between the two genera in their premolars, down even to the number of grooves, however trivial and unimportant the character may appear to be, has, I confess, weighed greatly with me in forming my opinion. No special function has, as yet, been connected with the peculiarly grooved tooth of the living Kangaroo Rat. The agreement is therefore purely empirical; but as the character, according to our present knowledge, is confined, among many hundred genera of Mammalia, to certain species of *Hypsiprymnus* and to *Plagiaulax*, those who have faith in the constancy of the manifestations of nature will not lightly believe that it was common to these two genera alone without implying affinity; and when this is coupled with the obviously phytophagous type of the incisors, the conviction will be confirmed. I need hardly add that I regard the carnivorous deduction from the shape to be arbitrary and untenable.

[William Hunter, a century ago, by a parity of reasoning, arrived at the conclusion that the *Mastodon* of North America, from the trenchant form of the transverse crown-ridges of its molar teeth, was an extinct, colossal, carnivorous animal, in short, a kind of predaceous flesh-eating Elephant.[1] The error in his case, as in the corresponding one of Leibnitz, was excusable, comparative anatomy having been then in its infancy. But it is not a little startling to see the same sort of unsound deduction reproduced, in regard of one of the most pigmy of Mammals, half a century after Cuvier, by his luminous demonstrations, had indicated the method by which such signal mistakes might be avoided in future.—*Oct.* 15, 1862.]

Professor Owen perceives another indication of resemblance between *Thylacoleo* and *Plagiaulax* in the proportions of the large premolar to the succeeding molars. In both, there are but two molars, and in so far the agreement is clear; but no further. In *Plagiaulax* there are as many as four premolars; while in *Thylacoleo* the enormous development of the solitary premolar or carnassial is effected at the expense of the rest of the premolars, which are suppressed, and of the tubercular teeth, which are dwarfed. In the

[1] Phil. Trans. 1767, vol. lviii. p. 38.

former, as pointed out in my earlier description, 'the premolars are inordinately developed, while the true molars are dwarfed and rudimentary in proportion.' The operation of the well-known law of *Anamorphosis* or *Balancement* is visible in both. But examples of it are everywhere seen throughout animated nature, in the same organ, without reference to affinity, as, for instance, among the *Mammalia*, in the canine of *Machairodus* and of the Musk Deer. *Thylacoleo* and *Plagiaulax* may be regarded as being as wide apart among the Marsupials as the two former are among Placental Mammals. The solitary trenchant premolar in some of the species of *Hypsiprymnus* is said to attain a very large development. We have the authority of Professor Owen for the statement, that in two Potooroos of New Guinea its antero-posterior extent nearly equals that of the three succeeding molars.[1] If the teeth of *Thylacoleo* and *Plagiaulax* had been on the same morphological plan of construction, the agreement in the number of molars would clearly have carried weight; but, as such does not appear to be the case, the coincidence ought not to overrule the other indications, more especially as the form of the crowns of the molars in the two genera is totally different. In *Thylacoleo*, the first tubercular tooth has the crown compressed, supporting two cusps on its axis, the anterior lobe being more or less conical, with a smaller lobe behind it, both on the usual carnivorous type of construction. The second tubercular is only known through its socket. In both species of *Plagiaulax*, the two molars present oblong crowns, supporting two opposed lines of marginal eminences, separated by a depression. In my original description, I referred to the fact that in *Dromicia* and *Acrobata* the molars are reduced from the ordinary number, four, to three. In *Plagiaulax* the suppression is carried still further, two only being developed. The agreement in this respect between the latter and *Thylacoleo* does not impress me with the idea of affinity, although admitting, as I do, that it ought to be duly weighed.

I have entered in such detail upon the dental characters, because, by the consent of all observers, they are of paramount weight in the solution of a question of this nature. If the type be distinctly indicated by them to be herbivorous or carnivorous, the other characters, however modified they may be, will ultimately be found to be in relation to the teeth. The author of 'Palæontology,' having formed his opinion on the teeth, then examines the characters of the lower jaw, and finds them in conformity. He adduces the shortness of the horizontal ramus in proportion to its depth

[1] Odontography, vol. i. p 389.

as indicative of robustness; also the broad and high coronoid process, and the pedunculate condyle placed below the level of the grinding teeth (above, p. 432). They are all regarded as proving a carnivorous type. They were not overlooked in my former communication:—'The characters of the jaw are so peculiar, and in some respects of so mixed and complex a nature, that they ought to be weighed with caution, in conjunction with the teeth, in forming any opinion of the affinities of *Plagiaulax*. The low position of the condyle is so pronounced, and the elevation of the coronoid above it so considerable, that, regarded *per se*, supposing no teeth had been discovered, they might have been considered to imply, with some degree of certainty, a predaceous animal.'[1] But there were other characters, which, taken in conjunction with the jaw, appeared to me to counterbalance these indications —namely, the moderate extent and low elevation of the coronoid above the grinding plane of the teeth; the long neck and horizontal projection of the condyle behind the coronoid; the form of the condyle itself; and the absence of a stout angular process behind it. With one exception, I shall consider these mandibular characters briefly.

And first, as regards the shortness of the horizontal ramus in proportion to its depth. I refer my reader to fig. 13 of Pl. XXXIV., representing the side view of the lower jaw of the Aye-Aye. A glance will satisfy him that the horizontal ramus is much deeper in proportion to the length in this form than it is in *P. Becklesii*. The fact is so obvious that I do not think it necessary to enter upon the metrical details. Commonly we connect the idea of robustness in the lower jaw with the form and section of the mandible presented by the Hyæna and Tiger. If the sections in my original paper are referred to (Pl. XXXIII. figs. 2 & 3), it will be seen that they are totally different. The jaw of *Plagiaulax* in this respect also closely resembles that of the Aye-Aye.[2]

The coronoid process comes next for consideration. For the details of my description of it I refer my readers to p. 418 of my former paper. It is there stated that 'in general form the coronoid process in *Plagiaulax* resembles more that of the predaceous marsupials, and of the Ursine *Dasyurus* especially, than that of the herbivorous families. It differs very markedly from the elevated strap-shaped

[1] See *antea*, p 424—[Ed.]

[2] In the Koala (*Phascolarctus cinereus*), in which the procumbent incisors, as already observed above (p 436), are projected with an inclination resembling that of *Plagiaulax minor*, the horizontal rami of the lower jaw present great depth in proportion to the length, with a compressed section (Waterhouse, 'Mammalia,' vol i p 264) But the ascending ramus, in that genus, is on a totally different plan of construction

coronoid of *Hypsiprymnus* and the other herbivorous marsupials. It is to be remarked, however, that it is less elevated, and its surface of less area, than in the predaceous genera, whether marsupial or placental.' Here, it will be observed, the comparison was restricted to marsupial forms, beyond which I did not then think it necessary to carry it. If extended to the Aye-Aye (Pl. XXXIV. fig. 13), additional light is thrown upon the character. In both, the anterior edge reclines at an angle of about 45°; in both, the summit is not much elevated above the grinding-plane of the teeth. The appearance of elevation, which is at first sight suggested by the coronoid of *Plagiaulax*, arises from the great depth of the sigmoid notch and the low position of the condyle. If fig. 1 of Pl. XXXIII. be referred to, it will be seen that the process itself is not raised much above the summit of the premolars. There is a further agreement between the Aye-Aye and *Plagiaulax* in the amount of area occupied by the surface of the coronoid. This is partly disguised, in the lower jaw of the former, by the broad neck of the condyle and the shallowness of the lunate notch between it and the coronoid; if the notch were deepened, as indicated by the dotted line (*f*), the resemblance would be complete. I do not, therefore, admit the force of Professor Owen's remarks, as significant of carnivore affinities, that 'the lower jaw is short in proportion to its depth, sending up a broad and high coronoid process for the adequate grasp of a large temporal muscle'—seeing that all these characters are combined in an existing gliriform Lemur, which is not a carnivore. The descriptive terms applied to the coronoid would be suitable for that of a Tiger or Stoat, but they seem hardly applicable to the process of *Plagiaulax*.

The author of 'Palæontology' lays stress on the low position of the condyle and its long horizontal neck: 'The condyle is placed below the level of the grinding-teeth, a character unknown in any herbivorous or mixed-feeding Mammal; it is pedunculate, as in the predaceous *Marsupialia*; whilst the lever of the coronoid is made the stronger by the condyle being carried further back than in any known carnivorous animal.' But it is not a little remarkable that he is silent regarding the form of the condyle itself, the most important of all the mandibular characters after the teeth; for the peduncle, on which he lays weight, is, like the fang of a tooth, but the stalk upon which the organ performing the function is borne. I think it necessary therefore to call attention to the remarks on the subject contained in my former paper. In the true carnivorous type the condyle shows more or less of a cylindrical or terete surface, having

invariably a transverse direction, by which it is locked in the glenoid cavity of the upper jaw, thus constituting a pivot like that of a pair of scissors, which constrains the blades to a vertical motion. In *Plagiaulax* all these conditions are reversed, the condyle being convex, with its long diameter disposed subvertically; regarded endwise, it is narrow in proportion to the height, and the outline is ovate or pyriform, the broad end being uppermost. This is a form which is unknown among the *Carnivora*, but common in the Placental Rodents, with the difference, however, that in the latter, the condyle having to work backwards and forwards in a groove, its articular surface is disposed longitudinally. In the common Norway Rat, the articular surface of the condyle is partly vertical, with the pyriform outline of *Plagiaulax*, but more compressed; and in one of the American Marmots (No. 2,259, Mus. R. Coll. of Surgeons) it still more closely resembles that of the fossil genus. I cite these instances to show the undercurrent of Rodent analogy which pervades the jaw of *Plagiaulax* throughout. But a more conclusive and irresistible case of correspondence can be adduced in the condyle of the Aye-Aye. In the words of the celebrated French anatomist who first settled the affinities of the genus, 'La forme générale de la mâchoire inférieure de l'Aye-Aye dénote une partie forte, large, ou mieux haute et très-comprimée; la branche horizontale beaucoup plus longue que la verticale, qui est presque dans la même direction. Le condyle qui termine cette branche verticale, dans les autres animaux, est droite ici, et presque à l'extrémité postérieure de toute la mâchoire,' &c.[1] The condyle of the Aye-Aye has the same ovate form as that of *Plagiaulax*, but reversed, the narrow end being uppermost (Pl. XXXIV. fig. 13); the articular surface is broader and somewhat flatter than in that genus, but the direction of the greater axis is the same, that is, longitudinal and subvertical.[2] The glenoid surface of the upper jaw is modified in correspondence—being broad and flat, and placed on an inclined plane that would intersect the tips of the nasals and the middle of the occipital foramen. Here, then, is a signal failure in the chain of physiological deductions requisite to prove that *Plagiaulax* was a marsupial carnivore.

Next, as regards the depressed position of the condyle—below the level of the grinding-teeth. The author of 'Palæontology' states that it is a 'character unknown among

[1] De Blainville, 'Ostéographie' Mémoire sur l'Aye-Aye, p. 19.

[2] 'La mâchoire inférieure, comme celle des autres rongeurs, se meut évidemment au moyen d'un condyle longitudinal, de manière à empêcher tout mouvement horizontal, si ce n'est de l'arrière à l'avant et *vice versâ*' (Sandwith, Zoological Proceedings, 1859, p. 113.)

any herbivorous or mixed-feeding animal.' I again refer my reader to the figure (Pl. XXXIV. fig. 13) of the lower jaw of the Aye-Aye. In it, the articular surface of the condyle, although directed subvertically, or at the most diagonally, is wholly below the grinding plane of the molars. It looks still more depressed in *Plagiaulax Becklesii*; but this is, in part, owing to the inflected margin of the angle being broken off in the fossil, while it is entire and salient in the recent form, thus elevating the condyle above the lower plane of the ramus, and leading to an appearance of a greater amount of difference than exists in nature.[1]

For my reasoning as regards the signification of the long neck or pedicle of the condyle, I refer the reader to my former communication (*antea*, pp. 419 and 424). It is there stated that the low position of the condyle 'is counterbalanced by another character, of which, so far as I am aware, there is no example among any of the predaceous genera, either placental or marsupial, recent or fossil, namely, the long neck and horizontal projection of the condyle behind the coronoid,' &c.; and further on I added that the 'arrangement is equally without a parallel among the herbivorous or omnivorous tribes.' This latter remark was premature. I was then acquainted with the Aye-Aye only through the figures given by De Blainville,[2] in which the lower jaw is shown in apposition with the skull, thus concealing the coronoid, and its relation to the condyle. But if the accompanying figure (Pl. XXXIV. fig. 13) of the lower jaw detached be referred to, it will be seen that the condyle is not only below the level of the grinding plane, but that it is projected a long way behind the posterior edge of the coronoid, exactly as in *Plagiaulax*, and on the same plan of construction—the sole difference being that the sigmoid notch is shallow in the Aye-Aye, and deeply excavated in *Plagiaulax*. If the notch were deepened in the former, by removing the plate of bone behind and below the posterior edge of the coronoid, in the manner indicated by the dotted line (f), the resemblance would be complete. In order to place these facts of agreement beyond question, I give the following measurements of the relative proportions of the lower jaw in the Aye-Aye and *P. Becklesii*[3]:—

[1] In some of the families of the *Rodentia* the condyle is barely elevated above the grinding plane of the molars. See De Blainville 'Ostéographie: genus *Cavia*,' Pl. ii. Figs. *Cavia Cobaya* and *C. Capybara*; genus *Hystrix*, Pl. ii., and *Sciurus maximus*, Pl. i., while in others, e.g. *Castor*, both condyle and coronoid are well raised above the same plane.

[2] Ostéographie: genus *Lemur*, Pl. v.

[3] It must be borne in mind that fig 1 of my previous communication (Pl. xxxiii. fig. 1), from which the measurements of *P. Becklesii* are taken, is *magnified* two diameters; the dimensions are therefore

	Cheiromys Madagasc.	Plag. Becklesii.
	Inch	Inch
Length of jaw from condyle to incisive border	2·3	2·0
From condyle to posterior edge of coronoid	·6	·5
Height of jaw to summit of coronoid	1·2	1·0
Height of ramus in front of first true molar	·7	·6
Height of ramus behind the incisor	·65	·45
Height from condyle to a line dropped vertically behind last molar	1·25	1·05
Height from the latter point to posterior edge of incisor at diastemo	·8	·75

From these proportions it will be seen that both in *Cheiromys* and *Plagiaulax* the condyle projects behind the edge of the coronoid to the excessive extent of about one-fourth of the entire length of the ramus. Professor Owen meets the argument in my paper by the assertion that the condyle of *Plagiaulax* is 'pedunculate as in the predaceous marsupials.' If so, I invite him to adduce the instance, bearing in mind that the question here is one of degree. The lower jaw of a tiger now before me measures 9·2 inches from the condyle to the incisive border, while the projection of the articular surface behind the fall of the coronoid does not exceed ·7 of an inch, or one-thirteenth of the length of the jaw. In *Dasyurus* and *Thylacinus*[1] the condyle projects behind the coronoid, but nothing approaching the extent seen in the Aye-Aye and *Plagiaulax*. As regards the functional effect of the condyle being carried so far back behind the edge of the coronoid, it is a plain question of animal mechanics, which the author of the 'Palæontology' thus interprets :—'It is pedunculate, as in the predaceous *Marsupialia*, whilst the lever of the coronoid process is made stronger by the condyle being carried further back than in any known carnivorous or herbivorous animal.' As I regard it, a necessary effect would be to restrict the power of separating the jaws in front, essential to a predaceous animal having laniary teeth constructed to pierce, retain, and kill. And we have the direct proof in the Aye-Aye, that the same arrangement there is not applied to a carnivorous function.[2]

doubled. But this does not interfere with the ratios of proportion. Further, in the Aye-Aye the posterior margin of the coronoid is assumed to be continued down vertically, in order to get corresponding measurements. The dimensions of *Cheiromys* are of the natural size.

[1] In the Ursine *Dasyurus* (No. 1900, Mus. R. Coll. of Surgeons) the length of the lower jaw is 4·2 inches, and the projection of the articular surface behind the deepest part of the sigmoid notch ·4 inch, or about one-tenth of the entire length of the jaw. In (No. 1903A of the same collection) the projection of the condyle is about one-eighth of the length of the jaw. But in both these forms the posterior edge of the apex of the coronoid overhangs the condyle; while both in *Pl. Becklesii* and the Aye-Aye the articular surface of the condyle is removed about one-fourth of the length of the jaw behind the fall of the coronoid.

[2] In the typical *Carnivora* the fulcrum is a fixed point, the form of the

With reference to the angular process, I have nothing to add to what is set forth in my former communication. This process, which is a very constant character of the carnivorous jaw, is wanting as a salient apophysis in *Plagiaulax*, although well developed in the minute insectivorous *Myrmecobius*.

I have one remark more to make in reference to the form of *Plagiaulax*. Fig. 2 of Pl. XXXIV. gives a representation of what remains of the lower jaw of *P. minor*, magnified to a scale of four diameters. The entire length of the specimen, including the six molars and premolars, together with the procumbent incisor (according to the metrical line *e*), does not exceed ·4 of an inch, of which the six cheek-teeth united make only about two and a half lines (·25 inch). I ask any zoologist or comparative anatomist to look at it, and say whether the dental apparatus of this extremely minute creature is competent to perform the duties required of a predaceous carnivore. Magnitude in this case is an important ingredient, as it necessarily involves measure of force. Could *P. minor* have preyed on small Mammals and Lizards? Is it not more probable that this pigmy form was itself an object of prey in the Purbeck Fauna?

In the preceding observations I have gone *seriatim* into the objections raised against the view which I advanced of the affinities of *Plagiaulax*. In the work referred to, every detail of external form was regarded in a light different from that in which it was viewed by me; every inference was controverted; and the conclusion drawn from the whole was diametrically the converse of that arrived at by me. The verdict of Comparative Anatomists will decide which is right. I have reconsidered my first inferences, and tried to test their validity by the strongly contrasted and extreme view put forward by Professor Owen; and the result has been to confirm the opinion that *Plagiaulax* did not belong to a carnivorous type of Marsupials. Regarded morphologically, in the plan of its dental system; rationally, through its condyle and correlated characters; and empirically, by comparison with *Hypsiprymnus* and *Cheiromys*, it has led me, through every aspect, to this conclusion. Enough has been adduced in the fore-

glenoid cavity preventing protrusion or retraction of the lower jaw; and the muscular power being applied close to the condyle leaves the free part of the lever longer, or, in other words, admits of a wider separation of the jaws in front, for the canines and cutting-teeth to act. In the Aye-Aye and Rodents (e.g. *Cavia* and *Hystrix*) the fulcrum is moveable, the condyle playing on a flat glenoid surface; the point of insertion of the muscular power is more advanced, leaving a short portion of the lever free, and thus restricting the aperture of the jaws. These conditions combined with the oblique direction of the temporal muscle, implied by the reclining coronoid, conspire to produce the antero-posterior and lateral motions required by the regimen of these forms. The same reasoning applies to *Plagiaulax*.

going pages to show that, to whatever family comparative anatomy may ultimately consign the genus, it must always be held to be a singularly modified form. I have directed attention to the numerous points of analogy between the lower jaw of *Plagiaulax* and that of the Aye-Aye, itself one of the rarest and most aberrant of existing *Mammalia*. They agree in the collateral position and upward direction of their strong incisors; in the depth and shortness of the horizontal ramus; in the backward continuation of the ascending ramus in the same horizontal line with the body of the jaw, and in the terminal position of the condyle—the two latter characters not being found, so far as is at present known, in any other *Mammalia*, fossil or recent. They agree further in the form and direction of the articular surface, in the reclinate coronoid, and in the backward projection of the condyle behind it. The two jaws are on the same plan of construction. Starting from the deep narrow incisors of the Aye-Aye carried back below the molars, the great depth of its jaw, and the other associated characters, can be seen to be in necessary correlation. In *Plagiaulax* they are all presented in a less degree of development. The resemblance goes no further. I doubt if in the fossil genus the lower incisors were opposed in the upper jaw by only two chisel-shaped teeth as in the Aye-Aye. In all the other dental characters they are widely distinct. In *Plagiaulax* the force of the dental system is manifested in the great development of the premolars, of which there are none, at least in the adult state, in *Cheiromys*, but a vacant bar instead. In the latter there are three molars; in the former, only two. While, therefore, admitting that the common construction of the jaw involves some trait of habit common to the two and essential to their existence, it does not impress me with the idea of affinity. For the reasons which have led me to regard the nearest relationship of the fossil genus as being in the direction of *Hypsiprymnus*, I refer to my former communication *passim*, and to the preceding pages. Both genera appear to be Marsupial: their incisors are on the same morphological plan, and their premolars are in the main identical, except in point of number. The Aye-Aye is a nocturnal animal, which uses its strong incisors as a nipping-apparatus, for breaking and detaching bark and wood in pursuit of the larvæ upon which, in part, it is said to feed. One of the live specimens procured by Sonnerat, on the first discovery of this form, lived in captivity two months fed on boiled rice.[1] The species of *Hypsiprymnus* are strictly vegetable-feeders.

[1] 'Il a vécu près de deux mois, n'ayant pour toute nourriture que du riz cuit; il se servait, pour le manger, de ses deux doigts comme les Chinois

I shall adduce a celebrated case to show how little we should be authorized to pronounce with confidence on the nearest affinities of *Plagiaulax* from the small measure of evidence we now possess. The Aye-Aye (*Cheiromys Madagascariensis*) was discovered by Sonnerat before 1782. The elder Geoffroy and Cuvier placed it among the Rodents. In 1816, De Blainville submitted the skull and teeth, together with the bones of the fore-arm, to a rigorous examination, and convincingly pronounced the Aye-Aye to be a Lemurine Quadrumane. Notwithstanding the evidence supplied by the brain-case, teeth, and bones of the fore-arm, Cuvier persisted in regarding the animal as a Rodent, and in the 'Règne Animal,' of 1829,[1] he placed it between the Squirrels and Marmots. If, with such a full measure of evidence before him, the position of *Cheiromys* in the natural system was so long erroneously contested by Cuvier, how little warranted should we be to pronounce dogmatically upon the food and habits of *Plagiaulax* from the slender evidence of the lower jaw! Supposing that *Cheiromys* were only known to us through its mandible, what would now be its inferred position among the *Mammalia*? While, therefore, regarding *Plagiaulax* to have been of a phytophagous type in its affinities, we should not be justified in affirming that it may not have been a mixed-feeder; it may have fed on buds or fruits, like the Phalangers; or on roots, like *Hypsiprymnus*; or on a mixed regimen of fruits and insects, like the Aye-Aye.

But I maintain that every argument which has been adduced by the author of 'Palæontology' to prove that *Plagiaulax* was carnivorous has been met in the preceding pages. The method by which the opposite conclusions have been arrived at are as different as the results themselves. Professor Owen, in so far as his method is disclosed to us, has gone direct from the indications of form to the supposed function; and he claims for the inferences, that they are physiological deductions. Comparative anatomists will decide how far they are entitled to the name. Mere external form must be handled with caution as an instrument of research; signal mistakes in Palæontology have been committed through too confident reliance upon it. On the other hand, the method which I have attempted to pursue was, first to ascertain upon what morphological plan the teeth of

de baguettes' (Sonnerat, quoted in Buffon, Supplément, tom vii. p 268) The early account of the French traveller has been confirmed by the later and excellent observations of Dr. Sandwith, who fed his captive Aye-Aye upon bananas and dates, the latter of which it took to with great relish, gnawing the larvæ of insects out of the branches of trees, and feeding on them when it had the opportunity. (Sandwith, Zoological Proceedings, 1859, p 113)

[1] *Op. cit* p. 195.

Plagiaulax were constructed, and, having determined this, to supply the rest empirically by comparison with known forms, using at the same time rational analysis where it could be applied, *e.g.* to the condyle. The case is of sufficient interest and importance to test the sufficiency of the respective modes of analysis.

In the general remarks appended to my former communication, I called attention to the contradictory bearing of the dental system of *Plagiaulax* upon the assumption that the earliest Mammals had the full complement of teeth. To that may be added the further evidence of specialization, in the analogy of its mandible with that of the Aye-Aye, one of the most exceptional of Mammals. If we cast a glance over the instructive table given in Lyell's 'Supplement' (page 23), and reflect on the interpretation of the hiatus between the Upper Oolitic beds and the 'Sables de Bracheux,' how vast the interval in time by which they are separated, and how modern in comparison the earliest of Tertiary Mammals! If, on the other hand, *Plagiaulax* be regarded through the medium of the view advocated with such power by Darwin, through what a number of intermediate forms must not the genus have passed before it attained the specialized condition in which the fossils come before us! What a variety of Mammals may we not hope to disentomb from the buried Oolitic fauna, should Mr. Beckles resume his explorations, or another Beckles take his place!

The remote antiquity of the fossil as a mammalian genus must alone invest the discussion of its affinities with an interest which will prevent the question from resting in its present disputed state. Other palæontologists will examine the evidence, and give their verdict. Mr. Beckles's specimens have long since passed out of my hands; and I have deferred my rejoinder in the expectation that they might ere now have found their way into some public collection, where I could have again submitted them to examination and comparison; but, as that has not yet taken place, I have thought it full time to reply, lest my silence should be construed into a tacit acquiescence in the carnivorous character attributed to *Plagiaulax*, which I do not accept—nor the reasoning on which it is founded.

IX. NOTE ON THE OCCURRENCE OF *SPERMOPHILUS* IN THE CAVE FAUNA OF ENGLAND.[1]

The glacial or northern character of the greater part of the Cave Fauna of England is so well-known, that no surprise will be excited by the announcement of the addition to it of a mammal genus, the habitat of which is now restricted to the Arctic Circle and the northern parts of Europe, Siberia, and America.

In 1842, MM Desnoyers and Constant Prévost announced the discovery of abundant remains of *Spermophilus* (*citillus*), from the bone-breccia of the caves and fissures of Montmorency, in the gypsum of the Paris Basin.

In 1859, while examining the rich collection of fossil bones, made by the late Rev. Daniel Williams, from the numerous caves of the Mendip hills, and now preserved in the Museum of the Somersetshire Literary and Philosophical Society at Taunton, I detected two rami of the lower jaw of a species of *Spermophilus*, which, by the kindness of the Rev. W. Arthur Jones, I was enabled to compare with recent specimens in the metropolitan collections.

The most perfect remain consists of a right ramus, containing the incisor and three last molars *in situ*. The most anterior of the molar series (last premolar) is wanting, probably a recent loss, as the alveolus is free from matrix. The jaw is in a singularly good state of preservation, showing the condyle, coronoid, and posterior angle, quite entire; the only damage being a slight abrasion of the lower margin near the angle, and a small film broken off from the anterior side of the incisive sheath. Figs. 1–3 of Plate XXXV. represent the fossil, top and side aspects: fig. 1 showing the crowns of the molars, and figs. 2 and 3 respectively the inner and outer sides of the jaw erect.

The well-known characters of the genus *Spermophilus* are so clearly shown by the fossil, that it is not necessary to describe the teeth in detail. The following are the principal dimensions of the Spermophilus from Taunton: [2]

April 8, 1858.—Length of jaw from posterior surface of condyle to anterior edge of incisive sheath, 1·35 in. Ditto from posterior angle (lower margin) to ditto, 1·35 in. Length of three posterior molars, 0·4 in. Length of line occupied by the four molars, 0·52 in. Length of diasteme, 0·32 in. Length of mentary suture, 0·32 in. Length of exserted portion of incisor, 0·25 in. Length from posterior margin of condyle to anterior edge of coronoid, 0·33 in. Length from bottom of sinus between condyle and posterior angle to anterior edge of masseteric disc, 0·7 in. Length from ditto to anterior edge of incisive sheath, 1·2 in. Height of coronoid to line of bottom of sigmoid notch, 0·22 in. Width of ditto at the middle, 0·1 in. Extreme height of jaw to the apex of the coronoid, 0·65 in. Ditto behind

[1] This paper was commenced in 1858, but was never completed. The deficiency has been supplied by extracts from the author's Note-books, and from a letter to M. Lartet.—[Ed.]

[2] The remainder of the paper is made up of extracts from the author's Note-books, &c.—[Ed.]

it, at sigmoid notch, 0·45 in. Ditto from condyle to lower margin near angle, 0·52 in. Ditto of ramus at last molar, inner surface, to alveolar border, 0·33 in. Ditto of ramus at second molar, inner surface, to ditto, 0·33 in. Ditto at outer edge of first molar to alveolar border, 0·23 in. Ditto of ramus, where constricted, close behind the suture, 0·2 in. Ditto of masseteric disc, under last molar, 0·31 in. Width of ascending ramus from sinus behind to coronoid margin at alveolar border, 0·45 in. Length from anterior border of masseteric disc to tip of incisive sheath, 0·45 in.

June 2, 1858.—Compared the Taunton Spermophilus with all the specimens in the British Museum, viz.: *Sp. erythrogenys* (Pl. XXXV. figs. 8 and 9) of Siberia; *Sp. musogaricus* of the Altai mountains; *Sp. lateralis* of N. America; *Sp. Douglasii*, *Sp. Harrisii* of N. America; *Sp. concolor* (Souslik) of Moldavia (Pl. XXXV. figs. 4 and 5); *Sp. Parryi* of N. America; *Sp. Eversmanii* of the Altai mountains (Pl. XXXV. figs. 6 and 7); and *Sp. Franklinii*. The jaw of *Sp. Franklinii* is of the same size, but the body is deeper and the sigmoid notch shallower. On the whole, the fossil approaches nearest to *Sp. erythrogenys*, although the teeth are larger.

November 12, 1859.—Again compared the Taunton Spermophilus with the skulls in the British Museum, along with Gerrard. The fossil is certainly a Spermophilus. It differs from the Souslik specimen (*Sp. concolor*) in being as long to the tip of the incisive sheath, as the latter is to the tip of the incisives; three teeth also in the fossil are equal in length to four in *S. concolor*. The fossil agrees most nearly in form and size with the *S. erythrogenys* of Siberia (Pl. XXXV. figs. 8 and 9). It has the same bold masseteric disc, and the form of the coronoid is the same, but it is a little larger. The fossil differs from the *S. Eversmanii* of the Altai mountains in being a little larger. The form of the coronoid and the sigmoid notch, however, are exactly alike. In *S. erythrogenys* the coronoid is more erect than in the fossil from Taunton, and the notch differently formed.

July 27, 1860.—Mr. Waterhouse compared the Mendip Spermophilus with the European and N. American specimens in the Osteological collection of the British Museum, and found it nearest to *S. erythrogenys*, but the teeth are larger, and the fore and aft diameter relatively greater. The length of the line occupied by four molars in *S. erythrogenys* is ·4 in.; in the Mendip specimen it is ·52 in. Mr. Waterhouse considers the fossil wholly different from all the other species. I will call it *Spermophilus erythrogenoides*.

[On Nov. 28, 1862, Dr. Falconer received from Dr. H. P. Blackmore of Salisbury, a letter enclosing sketches of a Spermophilus found by him in the Pleistocene clay at Fisherton, near Salisbury. The remains of as many as twelve individuals had been found. The frontal bone was flattened and depressed, the superciliary ridges elevated, forming strong post-orbital processes extending backwards, as in the *Spermophilus superciliosus* of Kaup. On Dec. 20, 1862, Dr. Falconer took the drawings to the British Museum and made the following note.—Ed.]

'Compared the drawing from Salisbury (Pl. XXXV. fig. 10). None of the lower jaws of the living species have the slender reclinate pedicle to the condyle as in the fossil, nor the same erect stumpy coronoid (is it entire in the fossil?); but *S. musogaricus* from the Altai has got the brow concave between the frontals, with elevated superciliary ridges, as in Kaup's *S. superciliosus*. The horizontal condyle of the fossil differs

much. The post orbital processes are very much hooked backwards in a Russian skull of *S. musogaricus*, but they are not so divergent or spread out as in the fossil. The palatine slits are very large in the drawing of the fossil.'

Extract from Letter to M. Lartet, June 27, 1864.—'With regard to the Spermophilus: there are three species in the British Museum, the lower jaws of which are nearly of the same size, and, with certain differences, very much alike in form. These are: *S. concolor*, *S. Eversmanii*, and *S. erythrogenys*. But unfortunately, the number of specimens of each is too limited to determine what the range of variety of form is in each. On comparing the materials, I found the cave Spermophilus of the Mendip hills to come nearest to *S. Eversmanii* and *S. erythrogenys*; but most closely to resemble the latter. I therefore called it *S. erythrogenoides*. The lower jaw from M. Desnoyers (Montmorency) appears to me to resemble the Mendip Cave form very closely. I believe them to be the same. But the Spermophilus from the gravel of Salisbury is considerably larger, with a very broad ascending ramus, a long neck to the condyle, and other differences. Possibly there are two fossil species in England; and neither of them the "Souslik," *i.e. S. concolor*. The name of *S. erythrogenoides* is provisional.'

Fig 1

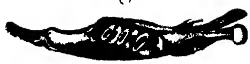


Fig 2

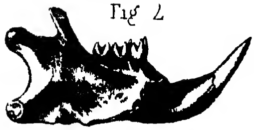


Fig 3

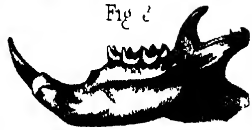


Fig 4

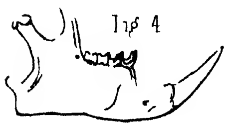


Fig 5

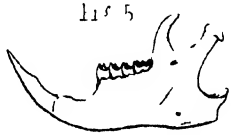


Fig 6

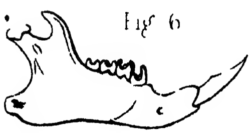


Fig 7

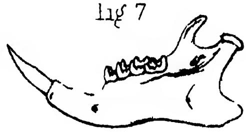


Fig 8

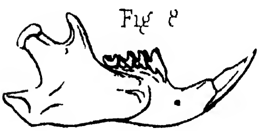


Fig 9

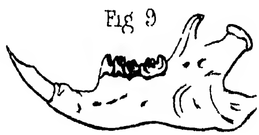


Fig 10

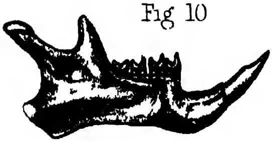
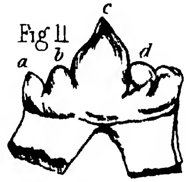


Fig 11



1 2 3 Spermophilus erythrogenoides 4 5 S concolor
6 7 S Eversmanni 8 9 S erythrogenys 10 S from Salisbury
11 Felis spelæa

Jos Dinkel del Lens Aldous lith.

Harrison & Sons Imp^t

X. NOTE ON THE OCCURRENCE OF FELIS SPELÆA IN THE MENDIP CAVERNS AND ELSEWHERE, AND ON A SPECIES OF FELIS FOUND IN ONE OF THE GOWER CAVES.[1]

THE late Reverend D. Williams, Rector of Bleadon, is well known for the zeal with which he devoted himself, during many years, to the exploration of the ossiferous caves in the Mendip hills. His large collection of fossil bones was chiefly derived from the caves of Bleadon and Hutton; but although the origin of most of his specimens was probably readily recognized by himself, he, like many collectors, failed to mark the remains from different localities by distinctive labels; and when his collection passed into other hands, the precise history of many specimens was lost. Such appears to have been the case with the three carnassial teeth about to be described. They form part of his collection in the Taunton Museum, where they were kept together, carefully attached to a card, and marked numerically, but without any note or memorandum of their exact origin.

The specimens are three detached upper carnassial molars of the milk set of young animals. Two are of the right side of the jaw, and one of the left. It is evident that two of the three belonged to opposite sides of the same individual, agreeing, as they do, exactly in size, colour, and form, down to the most minute particulars.

The most perfect specimen, being the right carnassial of the pair, is represented by fig. 11 of Pl. XXXV. It is in the most remarkable state of preservation, both as regards the lobes of the crown and the very fragile and attenuated shells of the fangs which are entire to their base. The crown, as compared with the corresponding milk tooth in the young Lion or Tiger, is thinner and more compressed. As is normal in the *Felidæ*, the blade is distinctly trilobed. The anterior lobe, which is low, is deeply bifid, showing two conical and subequal tubercles (*a*, *b*), separated by a very decided notch. The anterior tubercle (*a*) is roundish, terminating in an edge which is directed diagonally inwards. The second tubercle (*b*) forms a sort of obtuse three-sided pyramid, the inner and posterior face of which is elevated by an inclined step above the inner surface of the middle cusp. It is thus intruded inwards beyond the plane of the latter and of the anterior tubercle, its inner angle forming a sharp curved ridge, and presenting somewhat the appearance of a surface abraded by wear. The middle lobe (*c*) forms a compressed semi-conical entire cusp, flattish on the inner side and convex on the outer; its anterior margin is but slightly inclined, straight, and obtuse; the posterior margin is convex in outline, and thinned off to a trenchant edge. This middle cusp, at its base on

[1] This paper, on the carnivorous teeth from the Mendip caverns, was commenced by the author on the supposition that the teeth belonged to *Machairodus*. Subsequent examination and comparison, however, as shown by extracts from his Note-books, satisfied him that they belonged to *Felis spelæa*.—[ED.]

the inner side, contracts into a narrow band which slopes inwards, terminating in a middle fang which diverges inwards. The sloping basal surface is the obsolete representative of the inner tubercle of the upper carnassial in the *Felidæ*, which is well developed in the Tiger and Lion, but greatly reduced in the Drepanodons. This rudimentary tubercle and diverging fang are given off from the middle of the blade in a line with the apex of the central cusp, proving the tooth to have belonged to the milk set. In the adult carnassial tooth of the *Felidæ* generally, the inner tubercle is thrown out much further forward, and opposite the sinus between the anterior and middle lobes with which it alternates.

Extracts from Dr. F.'s Note-books.

British Museum, October 2, 1858.—Received from the Rev. William Arthur Jones the three carnassier teeth from Taunton. Compared them at the British Museum with the cast of Bravard's *Felis Megantereon* (*Machairod.*); with an original carnassier of *Smilodon*, belonging to the defective side of De Blainville's skull; and with the young *Machairodus* of the Sewalik hills, noticed in Owen's 'Brit. Foss. Mam.,' p. 178, also with a young *Felis spelæa*, having milk dentition, from Kent's Hole.

In the Sewalik specimen the carnassier (right upper) is formed with a very thin blade. The anterior lobe is damaged, but judging from what remains, it would seem to have been two-lobed, as in the Taunton specimen. The middle cusp is thinner, but pointed and formed like the English specimen. But neither the anterior lobe nor the middle one bears the slightest indication of bearing an internal tubercle. If ever there, it is gone. Owen describes it as being there, 'but less developed than in the normal species of *Felidæ*.' The posterior lobe is nearly horizontal, and very trenchant; in fact, the tooth is compressed and sharp-edged. All the points rise.

Length of crown, ·75 in.

There is an interval between the carnassier and canine of 0·3 in., part of which has been artificially rubbed down, but there is not the least indication of a fang-pit or fang. (Owen says there is, and that it is single-fanged and simple!) There is a distinct show of the fang—two, fore, and aft—of a tubercular in a line with the sectorial behind it. The breadth of the canine at its base is 0·5. It is very compressed. The posterior concave edge is finely serrulated; the anterior is entire. Owen says that both edges are distinctly serrated.[1]

In Bravard's cast of Megantereon (No. 28,882) there is a trilobed premolar on the left side. The carnassial has the anterior lobe entire, as in the true *Felidæ*, and not bilobed. It is thicker than in the Sewalik or English form. The middle cusp is rather thick and short, as in the Cave Lion, and the posterior cusp is horizontal and bilobed externally. But the principal point to notice is, that the internal tubercle is given off at 3 lines from the anterior margin, and about 8 lines from the posterior, or at the anterior fourth nearly of the tooth.

Length of carnassier, 1·1 in. Breadth of canine, ·75 in. Ditto in Lovell Phillips' English specimen,[2] 1·11 in.

[1] See vol. i. p. 550, and Plate xxv. fig. 5.—[Ed.]
[2] See p. 161.—[Ed.]

The latter is also young, so that it is of a different species.

In the adult Cave Lion (No. 28,553), from Lundwig Cavern, the carnassier is thick and massive. The anterior lobe is simple. The internal tubercle is very much in front, being in a vertical line with the commissure of the two front lobes, sloped off and bearing no tubercular or raised edge. The length of the carnassier is 1·5 inch.

But in a specimen of young Cave Lion from Kent's Hole (No. 18,982), comprising the left upper maxilla with the orbit, milk premolar, milk carnassier, and the permanent carnassier coming behind it in germ, the following characters are observed. The length of the crown of the milk carnassier is 0·9 in. The anterior lobe is distinctly bitubercular, and the tubercles are not in the same line, the second being placed inwards alternately with the front tubercle and the middle cusp, which are in the same line. The middle cusp is not much elevated, and descending from the middle of the point, and very near the middle of the tooth (but slightly in front), is a distinct tubercle, supported on a pronged fang. This tubercle is distinctly raised like that of a Hyæna.

The Taunton specimens are very distinct from all.

The specimen belonging to De Blainville's Smilodon skull is the upper carnassier of the right side, with a premolar in front. It is thick and short, and 4-tuberculate. The central cusp is large. The length of the carnassier, which is partly broken behind, is 1·7 in. The height of the middle cusp outside, ·95 in. Ditto inside to surface of inner tubercle, 1·1 in. The tooth is long and massive, and the crown high; it is not so thick comparatively as in the Tiger. Anteriorly there is a cusp bearing a small tubercle in front in the same line, and separated by a distinct notch. The middle cusp is shaped as in the Taunton specimens; but it descends on the inner side as a distinct fang, which is nearly vertical. There is no mark of an inner tubercle as a distinct object. The fang divaricates less than in the English tooth. The posterior lobe is long, but the crown characters are not shown, owing to the fracture. The posterior fang is very broad, or two-thirds the length of the tooth. The internal tubercle is situated at one-third from the anterior margin, much more in advance than in the English specimen.

On careful comparison, however, with the *Felis spelæa*, the Taunton teeth appear to be the milk carnassiers of that species.

[In Dr. Falconer's Note-books there are also descriptions of fragments of the upper and lower jaws of *Felis spelæa*, among the Bielbeck fossils in the York Natural History Museum; of the upper and lower canines (probably from same individual), fragments of the lower jaw, humerus, and phalanges of the same species, in Dr. Spurrell's collection at Belvedere; also of a lower jaw, supposed to be from Erith (but this was doubted by Dr. F.), of *Felis spelæa*, in the collection of Mr. W. H. Newsted at Maidstone. The following note also appears to refer to another species of Felis.—Ed.]

Note on Felis from North Hill Tor.

British Museum, July, 1862.—Compared Colonel Wood's three specimens of *Felis*, from North Hill Tor, with skulls of Lion, Tiger, Leopard, Panther (*Leopardus varius*), Jaguar, and Puma; they cor-

respond nearest with the skull of a young, but adult, Lion or Lioness from Africa, No. 112, *c*.

Two of the canines from N. Hill Tor are a pair from the same individual, which must have been young, though adult, as the crown bears no mark of wear, either on the side or the apex. The right canine is the more perfect in the fang portion, while the left is the most perfect as regards the crown portion, half the shell of the fang in the latter being removed longitudinally. The principal points deserving notice about the fossil are the following:—

1. The posterior vertical cutting edge is very salient, forming a sharp keel.

2. The anterior mesial vertical ridge is very pronounced, terminating below in a gibbous bulb or prominence, near the termination of the shell of enamel; both the ridge and the bulb are more pronounced than in either the Tiger or Lion.

3. The outer vertical fissure is solitary, both in the fossil and in the Lion; but in the fossil it has a much longer stretch. In the Lion the fissure does not occupy one-third of the length of the crown, while in the fossil it occupies more than one-half (nearly three-fourths); the form, size, and contour of the crown of the canine of the Lion (112, *c*) and of the fossil are very much alike, the proportions, if anything, being larger in the recent animal.

The third canine from N. Hill Tor is a left lower, evidently of a very old animal, as the point, anterior surface, and part of the inner side, are far advanced in wear; in form and proportions it agrees closely with the young Lion, but it is shorter in the crown and longer in the fang; and the convex contour of united fang and crown is disposed in a curve of less convexity in the fossil; the bottom part of the fang is completely closed up, while in the young Lion it is still open.

The young fossil canines are very much of the same age and size as those of the young Tiger (114, *c c*).

XI. NOTE ON THE REMAINS OF DREPANODON OR MACHAIRODUS OF REPUTED BRITISH ORIGIN.[1]

REMAINS of the great feline carnivore of the Cave period, armed in the upper jaw with long compressed and falciform canines, are everywhere so rare in Europe, that I have been induced to examine all the specimens of reputed British origin. The dentition, characters of the skull, and closely feline affinities of the numerous forms belonging to the genus variously named Drepanodon, Megantereon, Machairodus, Stenodon, and Smilodon, by different palæontologists, are now well known, through the finely preserved materials discovered by Bravard in Auvergne, of his *Felis megantereon*, and by Lund in Brazil, of his *Smilodon populator*. But of the largest and most formidable of the European species, only one or two incisors and a few upper canines are at present known collectively, from a single cave of Kent's Hole in England, from Auvergne, and from the Val d'Arno. It is of importance in instituting a comparison between the Mammalian Faunas of England and Italy, during the Pliocene and Post-Pliocene periods, to collect all the materials calculated to throw light on the form or forms called *Drepanodon* or *Machairodus cultridens* and *latidens*, regarding which our information is as yet so limited.

Professor Owen founds the distinctness of his *Machairodus latidens* from the Italian *Machairodus cultridens*, on the proportionately greater breadth of the three English canines found by Mr. McEnery in Kent's Hole. The length of the Italian tooth is 8·5 in., and the breadth of the crown at the base 1·5 in.; while the corresponding measurements of the English specimen are 6· and 1·2 in. The breadth of the English tooth ought to be only 1·06 in., were the proportion to the length the same as in the Italian. Owen says these differences are constant and well marked. But are they sufficient for a distinction of species, or are the materials sufficiently abundant to affirm their constancy? I think not. In my opinion, the English *Machairodus latidens* is probably the same as the Italian *M. cultridens*.

The only specimens of Machairodus teeth of reputed British origin are, one in the Museum of the Geological Society, one in the Woodwardian Museum at Oxford, two in the British Museum, and one in the Museum of the Royal College of Surgeons.

1. The specimen in the Geological Society's Museum (No 23,413) is a fine canine of *Machairodus latidens*, very like the one figured by Owen in the 'British Fossil Mammalia' (fig. 69, p. 180), but of a

[1] The first paragraph in this memorandum was written as an introduction to a description of three carnassier teeth in the Taunton Museum, which the author at first believed to belong to *Machairodus*, but which careful comparison proved to belong to *Felis spelæa* (see page 455). The remainder is made up of extracts from the author's Note-books.—[ED.]

different individual. It is obliquely worn at the summit, and closely serrulated on the concave side; behind, there is a ridge without serrulation. The tooth is darkish externally, but very white within. The specimen is in a collection from Kent's Hole, presented by Mrs. Cazalet, February 16, 1826. There is a cast of it at Oxford, and in the British Museum.

During a late visit to Oxford, Professor Phillips told me that he had sent to York for an old letter in the records of the Natural History Museum, in which McEnery, as far back as 1826, mentions *Ursus cultridens* teeth, from Kent's Hole, as having been shown to Cuvier and Buckland.

In Plate F. of an unpublished work by Mr. McEnery, which was to have illustrated the fossil remains found in Kent's Hole Cave, Torquay, several figures are given of the teeth of *Ursus cultridens* (*Machairodus cultridens*). Figs. 1, 2, and 3 [1] are serrated on both sides, and apparently are different views of the same tooth. Figs. 6 and 7 are only serrated on the concave side; they represent apparently two teeth, although this is not quite certain. The teeth were found by Mr. McEnery in Kent's Hole, in January, 1826, and were mixed with teeth and gnawed bones of rhinoceros, elephant, horse, ox, elk, deer, hyænas, bears, wolves, foxes, &c.

2. In Professor Buckland's collection in the Woodwardian Museum, at Oxford, there is the original '*Ursus cultridens*' canine of McEnery from Kent's Hole, one of the three found by him there. At McEnery's sale, two of these three teeth were purchased by Dr. Lovell Phillips. One (this one) he presented to Dr. Buckland, and the other to the British Museum. On May 8, 1858, I had an opportunity of examing the Oxford tooth, and comparing it with the cast of a specimen also in Buckland's collection, and labelled 'Ursus cultridens of Issoire.' The tooth substance of the Kent's Hole specimen is very fresh looking and yellowish, apparently glazed over and preserved by drying oil. The apex is worn off and rounded. The wear is chiefly on one side, as in old Tiger canines, and a dirty vascular core is exposed. The serrature is very finely exhibited on the concave attenuated edge; there is none on the convex side, which is partly worn vertically, showing a denuded furrow through the enamel into the ivory. The convex side is rather thick. The base of the crown and the fang portion are also thick. In addition to the terminal loss, the fang is also corroded. The Oxford canine is evidently of a different age from that figured by Professor Owen in the 'British Fossil Mammalia' (fig. 69, p. 180). The cast above referred to is that of a corresponding, but younger, tooth. It is quite entire to the extreme tip, which is very sharp.

	Cast	Kent's Hole Specimen
	in.	in.
Extreme length along convex border . .	7·25	4·0
Length of crown portion	4·5	2·75
Greatest width of crown	1·4	1·15
Greatest thickness of ditto	·55	·65

[1] Figs. 2 and 3 of McEnery's Plate have been reproduced in figs. 8 and 7 of Plate xxv. of vol. i.—[ED.]

In the Oxford Museum there are also six other casts of Machairodus canines; but it is not known if they are English or Italian.

3. The other specimen purchased at McEnery's sale, by Dr. L. Phillips, was presented by him to the British Museum, where it now is (No. 14,954). It is an intact germ specimen, broken across at the fang portion, which is hollow. The tooth is very broad, flat, and pointed like a shark's tooth. It is excessively crenulated at both edges. The mineral condition is very white, as in Kent Hole specimens.

4. There is a specimen in the Museum of the Royal College of Surgeons (No. 103, Pal. Cat.), presented by Lord Enniskillen, and also reputed to be from Kent's Hole, Torquay. [In a letter from Dr. Lovell Phillips to Dr. Falconer, it is stated that the third Machairodus tooth at McEnery's sale was purchased by Dr. Battersby for 'some nobleman.'—Ed.]

5. The last specimen is also reputed to be of British origin, although this is doubtful. It is in the British Museum, No. 15,433, and is designated *Ursus cultridens* by Koenig. The blade is narrow, and there is no crenulation of the edges. It was purchased at McEnery's sale, but its mineral condition is certainly not that of Kent's Hole; it is dark and discoloured, as if from the Val d'Arno.

XII. NOTE ON THE REMAINS OF A HYÆNOID WOLF FROM SPRITSAIL-TOR CAVE.[1]

July 21, 1862.—Came with Colonel Wood to compare the lower jaw of the Hyænoid Wolf from 'Spritsail-Tor,' with the collections of recent species in the Osteological department of the British Museum.

This specimen consists of the greater part of the left ramus entire on the incisive border of symphysis, but the whole of the coronoid, condyle, and angular process wanting. There is also a fissure running from behind forwards into the ramus, below the carnassial, the bone at this part being wanting; but the inferior contour, nearly as far back as the angle, is perfect. The specimen contains *in situ* the four anterior molars quite perfect; the carnassial is also present, but the two tuberculars had dropped out, the fangs of the anterior one being shown; the canine and incisors had also dropped out. The alveolus of the canine is of very large size. (See Pl. XXXVI. figs. 1 and 2.)

The following are the dimensions as compared with a large European Wolf, with the *Canis occidentalis* of N. America, and with the *Lycaon venaticus* (or *Canis pictus* of De Blainville):—

	Spritsail Fossil	Wolf, 168 A	Canis occidentalis, 165 E	Canis pictus, 1041 B
	in.	in.	in.	in.
Extreme length of fragment . . .	5·70	—	—	—
Joint length of 4 premolars and carnassial	3·15	3·	3·85	2·37
Joint length of 4 premolars . . .	2·	1·90	2·20	1·52
Length of last premolar . . .	0·70	0·65	0 65	0·50
Length of carnassial	1·25	1·20	1·20	0·92
Greatest width of ditto near middle .	0·50	0·50	0·50	0·38
Greatest width of last premolar .	0·40	0·35	0·35	0·25
Transverse diameter of canine alveolus somewhat oblique . . .	0·60	0·40	0·45	—
Antero-posterior ditto	0·50	0·50	—	—
Height of jaw in front of first premolar	1·05	0 90	1·	0·95
Ditto between carnassial and last premolar	1·40	1·15	1·30	0·82
Ditto behind carnassial	1·40	1·30	1·30	0·92

With reference to the above comparative measurements, it is to be remarked, that in the American Wolf (*Canis occidentalis*) the premolars are very loosely set together, while in the three other forms they are compact. The striking difference of the fossil from the American and European Wolves is, that the last premolar has a small cusp in front of the large middle cusp, with two serratures behind it; this anterior cusp, or serrature, is entirely wanting both in European and N. American Wolves, fossil and recent, while it is very pronounced in the

[1] This note is from an entry in one of the author's Note-books.

Spritsail-Tor fossil specimen; as compared with the *Canis pictus*, the correspondence in this respect is exact, that species having a very pronounced anterior *cusplet*, which circumstance, together with the decided acumination of the central cusp, led De Blainville to name it *C. Hyænoides*. All the premolars have very pointed cusps in the latter species. As regards the carnassial, the form of the talon in the 'Spritsail' fossil resembles more the European Wolf in its considerable width and general form. The talon is narrower in the *Canis occidentalis*, and in the *C. pictus* it takes more after the *Hyæna* in form.

Further, in the Gower fossil, all the premolars (except the first) are, in a marked degree, thicker and more massive, in proportion, than in the existing European Wolf; and in this respect it differs still more from the *C. occidentalis*.

XIII. NOTES ON HYÆNA.[1]

I.—Synopsis of Nomenclature of Living Hyænas (1863).

A.

Hyæna, Storr. *Canis*, Linnæus.

Subgenus I. Euhyæna. Large tubercular above; lower carnassial with internal accessory point, either rudimentary or large.

1. H. (Euhyæna) striata (Zimmermann).
Syn. H. vulgaris (Desmarest).
" H. antiquorum (Temminck).
" H. orientalis (Tiedemann).
" H. fasciata (Odmann). Stockholm Trs.
" *Canis Hyæna* (Linn.).
" *Canis Hyænomelas* ? Bruce.

Subgenus II. Crocotta (Kaup). *Crocuta* (J. E. Gray).

2. H. (Crocotta) Crocuta (Zimmermann).
Syn. H. maculata (Thunberg. Petersburgh Trans.).
" H. Capensis (Desmarest).
Crocuta maculata (Gray).

3. H. (Crocotta) brunnea, Thunb. Stockholm Trs., 1820.
Syn. H. fusca, Geoffroy St. Hilaire.
" H. villosa, And. Smith, Linn. Tr., vol. xv. 1829, p. 460.
Crocuta brunnea (Gray, 'Tiger Wolf').
Hyène brune, Cuv., Fred. Cuv., '*Straand Wolff*' or Shore Wolf of the Boers.
Hyène var. Cuv., Oss. Foss., tom. iv. 384.
'Hyène dont la patrie est inconnue,' Cuvier.

B.

1. *H.* (*Euhyæna*) *striata*, Zimm. Habitat—India, N. W. P. of Hindostan; Persia; Syria; Asia Minor, to shores of Black Sea; Egypt; Barbary; Abyssinia? According to Andrew Smith, *not* found in South Africa; but *H. brunnea* (*villosa*), Smith, when young, resembles it. Bruce's *Canis Hyænomelas* on the Atbara affluent of Nile, doubtful; if real, of what species? Said by him to be very large. An *H.* (*Crocotta*) *brunnea*? I have seen *H. striata* tamed in India by the Rev. R. Everest, and kept in my grounds. Hindostanee: 'Luckrabugga' or 'Bughera.' Striped Hyæna.

2. *H.* (*Crocotta*) *maculata*, Thunberg. Habitat—South Africa and Abyssinia 'Tyger Wolff' of the Boers.

3. *H.* (*Crocotta*) *brunnea*, Thunb.
villosa, Smith. *fusca*, Geoffroy; 'Straand Wolff,' 'Shore' or 'Strand Wolf' of the Boers.

Habitat—Cape of Good Hope; Natal; Senegambia; Mozambique. Frequents seashore; nearly as large as *Hyæna spelæa*. Devours offal

[1] Extracted from the Author's Note-books. The memoranda A and B are of the same date.—[Ed.]

left by the tide. Is a true *Crocotta*, by the teeth above and below, and not a *Euhyæna*. Blainville's figure, Pl. III. is certainly not it, but *Hyæna striata*. *Vide* three fine skulls in the British Museum; one with Mr. Waterhouse, two with Dr. J. E. Gray.[1]

II.—Note on Skull of Fossil Hyæna in Florence Museum.

Florence, May 20, 1859.—Examined skull of *Hyæna* of large size, but broken vertically through the cerebral portion, about an inch and a half behind the orbits; the facial part with the palate and both orbits present. On the right side, one large premolar and the canine *in situ*; on the left, the carnassier with three premolars *in situ*, but a good deal broken, also the six incisive teeth. Looks like *Hyæna spelæa*, but differs very remarkably in showing two disc-shaped eminences, above the post-orbitary processes, forming a sort of step between the facial and cerebral portions, with a channel between.

Interval between the orbits, 2·9 in. Width of palate behind, 4·4 in. Length of palate in middle, about 4·4 in.

Not quite certain, but the disc-shaped appearance may have been caused partly by a crush (?). The specimen is a late acquisition, and from the Val d'Arno; it bears a label of interrogation, '*Hyæna Arvernensis?*'

III.—Note on Hyæna from the Cave of San Teodoro in Sicily.

'Oxford, July 5, 1860.—Compared with Baron Anca the upper and lower jaws of Hyæna from Sicily with Buckland's recent specimens. The Sicilian bones are certainly not of the Indian striped Hyæna, but of the *Hyæna crocuta*, or spotted Hyæna of the Cape.'[2]

IV.—Note on Hyæna from Caverna de Pedrara, Provincia de Segovia.

[This note is dated September 11, 1864, and refers to a fragment of the left ramus of the lower jaw, comprising the whole of the symphysis and the three premolars. It was transmitted to Dr. Falconer from Don Casiano de Prado of Madrid, through M. Lartet. On careful comparison in the British Museum, Dr. Falconer pronounced it to be identical with the *H. spelæa* of the English caves, and to be entirely different from Baron Anca's San Teodoro specimen.—Ed.]

[1] Since Dr. Falconer's death it has been shown by Mr. Busk that he was led into error by the three skulls in the British Museum, none of which really belonged to *H. brunnea*, the name they bore, and that, in fact, there was then no accessible specimen of a cranium of *H. brunnea* either in the British Museum or in the College of Surgeons. De Blainville's figure, according to Mr. Busk, is of *H. brunnea*. See Proc. Lin. Soc., May 3, 1866, p. 59.—[Ed.]

[2] Misled by the specimens in the British Museum, Dr. Falconer, subsequently in a letter to M. Lartet, dated Sept. 9, 1864, expressed the opinion that this identification was wrong and that the San Teodoro Hyæna was *H. brunnea*.—[Ed.]

XIV. NOTES ON FOSSIL SPECIES OF URSUS.

I.—Note on Fossil Remains of Ursus in Museum at Nice.

Nice, December 11, 1858.—Found one large detached canine of Ursus, very perfect, presented by Dr. Perez; also a fragment of an upper incisive; and a maxillary of a youngish animal containing three incisives, with the canine broken off short, and the transverse section of a very small premolar nearly touching the canine; also several detached molars, some upper, some lower. On a rough examination, without the means of comparison, approximated them to *Ursus priscus*, rather than to *Ursus spelæus*. Among the pieces sent to Gastaldi, there is also an upper incisive containing a canine, crown broken off, probably of the same species of Bear.

II.—Note of Lower Jaw of Ursus in the Norwich Museum.

Norwich Museum, June 6, 1862.—*Ursus* —— ? labelled, 'Cromer, from Miss Gurney's collection.' This is a left ramus, lower jaw, comprising the whole of the horizontal ramus from the incisive border back to near the angle, the ascending ramus, with the angle and posterior part of coronoid process, broken off; anterior edge of coronoid process present. Sockets of three incisors present, without teeth; canine *in situ*, beautifully perfect, comparatively small in size, with facet of wear inside towards upper third.

Four last molars *in situ* beautifully perfect; diastemal edge free for about an inch and a quarter; presents a small rudimentary stump-shaped premolar *in situ*, very much resembling that of fig. 35, p. 106, of Owen's 'Brit. Foss. Mam.' Dimensions:—

Extreme length from incisive border to fracture, 9· in. From incisive border to posterior edge, 7· in. Width of ramus at symphysis over sheath of canine, 1·3 in. Length of series of molars, 3·7 in. Extreme length of crown of last molar, 1· in. Extreme width of ditto, 0·8 in. Length of penultimate, 1· in. Width of ditto behind, 0·7 in. Width of ditto in front, 0·65 in. Length of antepenultimate, 1· in. Width of ditto behind, 0·55 in. Ditto ditto in front, 0·4 in. Length of last premolar, 0·6 in. Height of jaw to alveolar border between penultimate and last molar, 2·3 in. Ditto to alveolar border at middle of last molar, inner side, 2·65 in. Ditto at middle of last premolar, inside, 2·5 in. Height of jaw at middle of diasteme, 2·3 in.

The chief characters to be noted are these. The last molar shows the crown beautifully preserved, there being only slight marginal abrasion along the inner side; the pattern of crown surface is very complex; it differs from other Bears in the great proportion which the last molar bears to the penultimate; the length being the same, and the width much greater (*vide* fig. 35, above referred to, A. B. C.). The penultimate has the inner margin worn down to sublunate discs, the outer tubercles being nearly intact; form of crown oblong. The antepenultimate is of about same length as two last, but more compressed, and more advanced in wear. The pre-antepenultimate shows the disc of one large

sub-anterior outer cusp, bounded on the inside by three marginal tubercles of small size, but very distinctly defined. The canine is comparatively small; antero-posterior diameter of base of crown where enamel begins, 0·8 in.; transverse ditto, 0·6 in.; height of remains of crown, 1·02 in ; apex slightly abraded.

Ursus spelæus has an enormous canine in proportion.

III.—Note. Upper Maxillary of Ursus in Collection of Rev. S. W. King.

This specimen is a right maxillary, comprising the last two molars *in situ*, with the empty fang-pits of the antepenultimate, of an older animal than above jaw in the Norwich Museum, as is clearly proved by the crown of the penultimate being ground down to a uniformly smooth disc. The base of the zygomatic process and portion of palate, together with infra-orbitary foramen, are present; all rest broken off. Dimensions :—

Joint length of 2 molars, crowns, 2·4 in. Length of crown, last molar, 1·5 in. Greatest width in front, 0·8 in. Ditto behind, 0·65 in. Length of penultimate, 0·95 in. Greatest width of ditto, 0·75 in.

The last molar corresponds very closely in relative dimensions with those of the lower jaw in the Norwich Museum, and, as in it, the unworn talon portion exhibits a very complex pattern. The teeth in both are jet black, with a very bright vitreous polish. They would seem to have been yielded by two different individuals of the same species.

The detached canine found along with upper jaw (detached) is of comparatively small size, agreeing in this respect with canine of above.

IV.—Note on Ursus from Deborah's Den.

British Museum, July 22, 1862.—Comparison of lower jaw of Bear from Deborah's Den, Gower.[1]

This specimen is a finely preserved and nearly perfect right ramus of the lower jaw, entire from the incisive border to the condyle, and defective only in a slight portion of the outer casing of the canine alveolus. The posterior point of the coronoid is also slightly abraded, and a small portion is broken off the point of the angular process. The symphysial suture is shown throughout; the three incisors had dropped out, but the alveoli are distinctly shown; the canine is also *in situ*, slightly worn at the apex, which is somewhat truncated.

Of the molar teeth, only one is seen *in situ*, viz. the (m. 2) *penultimate*, and it is not a little remarkable, that although the animal is shown to have been a somewhat aged adult, there is not the slightest indication that the last tubercular was ever developed. The surface where it ought to have been found was perfectly smooth, and on drilling down into the dentary canal, not a trace of the tooth was found, nor in the base of the coronoid. The same absence of the last tooth sometimes occurs either on one or on both sides of the lower jaw of the

[1] 'Deborah's Den' was a cave discovered by Col. Wood, at Gower, in the autumn of 1861. It is situated about half a mile westward of Paviland Cave, and contained numerous remains of Bear, Wolf, &c.—[Ed.]

Polar Bear;[1] but in the instances observed the corresponding upper molar was constantly present.

Of the other molar teeth, the alveoli only are shown; of these anterior teeth there were four. First, a small premolar separated from the canine by the interval of about a line, as in the Polar Bear; then a vacant *barre*, 0·8 of an inch in extent, followed by another single-fanged premolar; this tooth was succeeded by a two-fanged last premolar in close apposition; and lastly, there is seen the double fang of a first molar, followed by the two-fanged alveolus of m. 2.

The penultimate molar in a general way presents the characteristic form of crown seen in the Bears; but it differs remarkably from all the specimens with which we have compared it, in the excessive width in proportion to the length of crown. In the *Polar Bear*, *Ursus ferox*, and *Ursus Arctos*, the crown of the penultimate is commonly a narrow oblong, while in the fossil it is of a very broad oblong form, as in *U. spelæus*; the coronal surface is slightly worn, but not to the extent of confounding the prominences. On the inner side (as in the Grisly Bear, 1137, B) there are four points, the two anterior of which occupying the front half are obtusely pyramidal, and somewhat as in the Grisly Bear, 1137, B., but less salient. They are slightly abraded at the apex. The two posterior inner points are much smaller, nearly equal in size, and depressed so as to form a step below the anterior points.[2] The outer side consists, as in the Grisly Bear, of two principal points, the anterior of which is ground down into a three-pronged disc; the posterior point is lower, and slightly abraded. In all these details of coronal prominences, the tooth of the fossil corresponds very closely with that of the Grisly Bear, although still maintaining a considerable difference in the proportion of length to width.

In the Cashmeer *Ursus Isabellinus*, 1010, F., the crown of the penultimate is broad in proportion to the length, but the surface is *excessively* warty and complex, resembling more that of a Hog, and some forms of *U. spelæus*. In *Ursus Arctos* the tooth is very much smaller, and narrow in proportion to the length, with finely warty subdivisions of the surface. In the Polar Bear, 221, B., the wartiness is still finer and more complex; this is beautifully shown in the last molar of that species; on the other hand, in all these details of surface, the crown of the fossil, as regards simplicity of pattern, approaches nearest the Grisly Bear, 1137, B.

The muscular impressions of the temporal show the fossil to be oldish.

In form of jaw, lower line of ramus, the fossil comes nearest the Polar Bear, in which the angular process rests on the ground plane; it does *nearly* the same in fossil. But in the Polar Bear there is no crook process under the middle of the coronoid. There is more or less crook in all the others. In *U. Arctos*, the *Cashmeer Bear*, and *U. ferox*, the angular process is well raised above the ground plane, and enormously so in *U. spelæus*. Coronoid in fossil broader and lower than in any of the others: nearest *U. ferox*; it has a crescentic outline behind: quite different in *U. spelæus*. Condyle in great depth and shortness, most like

[1] Thus, in the Brit Mus. specimen of Polar Bear, No. 221 G., there is no indication of an inferior last molar on either side, and in 221 B. it is present on the left side, but not on the right.

[2] In the Grisly Bear the points are nearly of uniform height from front to back.

Cashmeer Bear! and *U. ferox*; very different from Polar and Brown Bears. In short diasteme most like the Cashmeer Bear. In proportions of penultimate molar, most like *U. spelæus*.

The premolars are very inconstant in number in all the Bears. In Polar Bear, commonly in lower jaw p.m. 1 and 4. They seem to be most common and constant in the American Black Bear.

A specimen of *Ursus spelæus*,[1] said to be from Bacton (No. 16,418 Brit. Mus Cat.), figured in the Brit. Fos. Mam., fig. 35, c, is a beautifully perfect right ramus of the lower jaw, with the four last molars *in situ*. The penultimate agrees with that of the Bear from Deborah's Den, in its great width in proportion to its length, but the crown is more warty. I doubt much the asserted origin of this specimen. It differs from all the Bacton specimens that I have seen. It looks as if out of peat.

A set of Bear's jaws from Kent's Hole, although not agreeing with *Ursus spelæus*, are entirely different from the Deborah's Den specimen. Except that the condyle is much shorter, they resemble the Grays Thurrock specimens. This has the condyle enormously long, but the penultimate is of the same size and form as in the Deborah's Den fossil.

The Muggendorf skull of *U. priscus* has a small jaw, with a short diasteme, and the condyle is somewhat like that of the Deborah's Den fossil.

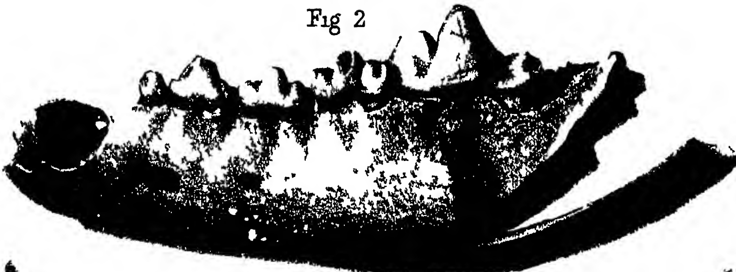
[Figures of the lower jaw of fossil *Ursus*, from Deborah's Den, are given in Plate XXXVI. The comparative measurements will be found over the page.—ED.]

[1] Dr. F. had at first great doubts whether this Bacton jaw belonged to *U. spelæus*, but after careful examination with M. Lartet, he came to the conclusion that it did.—[ED.]

Comparative Measurements	Fossil, Deborah's Den	Polar Bear, 221 G. Brit. Mus.	Ursus priscus. Brit. Mus.	Grisly Bear, 1137 B. Brit. Mus.	Bacton Bear. Ursus spelæus, 16,448 Brit. Mus.	Brown Bear, 62 3-29 L. Lloyd	Cashmeer Bear, white male, 1010 D. Brit. Mus.	Gibraltar Bear
Length from condyle to incisive border . .	9·50	about 10·	9·0	10·8	10·1	about 9·7	9·3	—
Length from anterior edge of coronoid to do. .	5·70	6·2	5·9	6·4	6·05	5·8	5·5	6·75
Length from do. to surface of condyle . .	3·70	3·7	3·4	4·2	4·1	3·8	3·7	—
Height of jaw at middle of diasteme . .	2·05	1·95	1·65	1·9	2·1	1·6	1·6	
Do. in front of penultimate	1·90	2·1	1·7	2·0	2·1	1·75	1·6	2·1
Do. behind penultimate	1·80	1·9	1·8	2·2	2·2	1·85	1·7	2·2
Width of coronoid at base	3·20	3·2	2·8	3·4	2·9	3·3	3·0	—
Height of do. to middle of apex behind crook .	3·90	4·3	3·8	5·	4·7	4·	3·8	—
Width of condyle—transverse diameter . .	1·75	2·4	1·8	2·2	1·7 broken	1·9	1·7	—
Greatest vertical height of do.	0·85	·65	0·7	0·8	1·00	0·6	0·8	—
Width of coronoid about middle . . .	2·55	2·2	2 1	2·6	2·15	2·05	1·95	—
Length of line of teeth from canine to posterior end of penultimate	4·1	4·2	4·15	4·4	3·9	4·1	3·6	4·45
Do. alveoli of m. 1. 2, and p.m. 4 . . .	2·7	2·3	2·5	2·55	2·6	2·3	2·3	2·75
Distance from p.m. 4 to canine . . .	1·4 (?)	1·9	1·7	1·5	2·3	[illegible]	1·4	1·7
Length of penultimate	1·1	0·9	0·95	1·0	[illegible]	0.95	0·95	1·25
Width of do. (greatest of crown) . . .	0·7	0·50	0·65	0·6	0·6	0·54 (?)	0·6	0·7
Length of last molar	—	—	0·7	[illegible]	[illegible]	0·7	0·85	—
Greatest width of do.	—	—	0·65	0·6	0·7	0·55	0·62	—

Fig 1

Fig 2



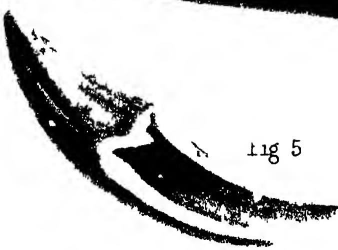


Fig 5

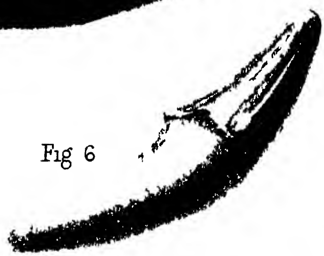
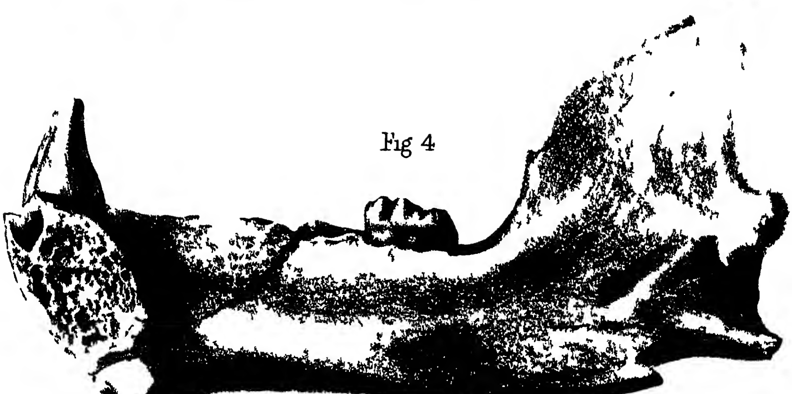


Fig 6

Fig 3

Fig 4



J Dinkel lith

W West imp

1 2 Hyænoid Wolf from Spritsail Tor 3,4 Ursus from Deborah's Den
5,6 Felis from N Hill Tor

V. NOTES ON FOSSIL SPECIES OF CERVUS, INCLUDING A DESCRIPTION OF A REMARKABLE FOSSIL ANTLER OF A LARGE SPECIES OF EXTINCT CERVUS IN THE COLLECTION OF THE REV. JOHN GUNN, IRSTEAD.[1]

THAT remains of large extinct species of Ungulata abound in the 'Forest-bed' and Laminated Clays, which are interposed between the Crag and the 'Boulder-clay' along the Norfolk coast from Cromer to Happisburgh, has long been well known. They are amply represented in the collection formed by Miss Anna Gurney, Mr. Foulger, and others, now deposited in the Natural History Museum at Norwich; in that of the Rev. James Layton, now absorbed in the British Museum; and in the private collections amassed during many years by the Rev. John Gunn of Irstead, by Mr. Fitch of Norwich, and more recently by the Rev. S. W. King of Saxlingham.

But our knowledge of the Mammalian species belonging to this extinct Fauna, regarded as a whole, is still in a very unsatisfactory state. The *Proboscidea* have yielded three well-marked species, with indications of probably a fourth: the former being *Elephas* (*Loxodon*) *meridionalis*, *E.* (*Euelephas*) *antiquus*, and *E.* (*Euelephas*) *primigenius*. The genus Rhinoceros has yielded two well-marked species, namely *Rh. Etruscus* and *Rh. leptorhinus* (*Rh. megarhinus* of Christol). It is worthy of remark, that although undoubted remains of *E. primigenius* have been yielded by the Forest-bed, its usual associate in the Quaternary Valley Gravels, *Rh. tichorhinus*, has not yet, so far as I am aware, been established upon reliable evidence. Two of the Fossil Elephants above-named and both species of Rhinoceros belong to the Pliocene deposits of the Val d'Arno and of the Valley of the Po, as exhibited in the Astigiana, and in the Sub-Apennines of Piacenza and the Romagna. It might therefore be inferred that the rest of the fauna would partake of a Pliocene character. Remains of the Ruminantia abound in all the collections, consisting of antlers and bones of large species of Cervus, and bones of the *Bovidæ*. But, commonly they occur in a

[1] The description of Mr. Gunn's antler was written in 1863, but was never published. I am indebted to Mr. Gunn for Dr. Falconer's description of crania of *Cervus* in his collection. Additions have likewise been made from the author's Note-books.—[ED.]

very fragmentary state. Of the antler, however, which forms the subject of the following description, Mr. Gunn has succeeded in uniting the numerous fragments, so as to render the specimen unusually perfect.

CERVUS.—Sub-gen. *Eucladoceros* (Falc.)[1]—Charact.: Horns pedunculate, branched, without brow- or bez-antlers; beam and compound antlers compressed, the latter thrown off forwards and terminating without palmation in long tynes.

C. (*Eucladoceros*) *Sedgwickii* (Gunn).—Horns very ample, indicating a large species. Bur prominent, without obliquity. Beam cylindrical and straight at the base, compressed upwards, giving from its anterior margin three sub-equidistant antlers, which from the summit downwards are successively bi- tri- and quadrifurcate. Tynes long, straight, and conical, diverging in the same vertical plane. A single elongated tyne or fork ? terminating the beam.

Habit.: Fossil in the indurated gravel pan of the 'Forest-bed' of the Norfolk coast at Bacton, south of Coal Gap. In the collection of the Rev. John Gunn.

The cervine horn to which the above definition applies is shown by the outer oblique ridge of the pedicle to be of the right side. The specimen was found in January, 1863, embedded in the matrix after the scouring action of a heavy gale, which denuded the 'Forest-bed;' and although broken up into a large number of fragments, the most of these were recovered; so that, with the exception of the branch or snag immediately terminating the beam, the outline of the perfect horn is fairly presented in its principal features. The whole of the pedicle is present, with the corresponding basal portion of the frontal, but without any determinable part of the orbit or cerebral cavity.

The pedicle is well developed, and of sufficient length to remove, in that respect, the species from affinity with the Reindeer, the existing Elk, and the Irish Elk. The bur is prominent, with large warty tubercles. The beam is cylindrical and straight at the base, for a distance of about four inches, where the first antler is given off. It is then reclinate in an easy curve, with a slight bend outwards, until above the offset of the median antler, whence it is curved gently forward as far as opposite the offset of the third or royal antler, where the commencement of another slight reclination is visible. The apex of the beam is broken off here on a level with the upper edge of the royal antler, leaving doubt as to the manner in which it terminated upwards, whether in a single elongated snag, or in a bifurcated branch.[2]

[1] See vol. i p. 587.--[ED]

[2] *Extract from Dr. F.'s Note-book.*—'The butt of the beam is very terete at the base and boldly channelled, and

From the offset of the supra-basilar, the beam and its main branches are broad and compressed, but nowhere to the extent of palmation; the section yielded by the former, being ovate, with constriction in the three intervals between the offsets of the successive antlers. The beam and its branches are boldly and closely channelled, the grooves being continued out on the flattened sides of the long straight tynes; but they are alike free from pearly rugosity.[1]

The two most striking characters about the horn consist: 1st. In the enormous spread of the tynes of the median and royal antlers, straight outwards from the beam, as compared with the length of the latter. 2nd. In the symmetrical direction of the elongated tynes of the median and royal antlers, which diverge forward in the same vertical plane.

The supra-basilar, or master-antler, being the lowermost antler, is thrown forwards and outwards, at right angles to the beam, its upper edge being about $6\frac{3}{4}$ inches above the bur. It is flattened for about 5 inches, and then bifurcates; each division again bifurcating, so that there are three forks and four snags, which are all in nearly the same vertical plane. The upper branch is directed nearly straight forwards, the lower inclines downwards. The snags are of unequal length, the uppermost or fourth being little more than an elongated tubercle. The tip of the second snag, which is above entire, stretches out about 17 inches from the beam. The expansion of the third snag, which is wanting, must have been greater. The first snag is also wanting, being broken off at its base.[2]

The second or median antler is thrown off about 6 inches above the supra-basilar. It is directed straight forwards from the anterior edge of the beam in a flattened branch, which, after stretching about 6 or 7 inches, bifurcates, the upper lobe consisting of a single, straight, flattened, conical, and slender tyne of great length, which inclines slightly upwards, an intermediate piece near the tip being wanting; while the lower lobe forms a flattened branch, which again bifurcates at about four inches. The upper tyne is directed straight forwards at right angles to the beam, and attains

upon the inner side the convexity of the section is continued uniformly upwards a little above the supra-basilar antler, while upon the outer side it is flattened. On examining the continuation of the beam immediately below the terminal section it is seen to be less flattened than the royal, the section measuring about $3\frac{1}{4}$ by $1\frac{1}{2}$ in.'—[Ed.]

[1] *Extract from Note-book.*—'The channelling is much more boldly developed upon the inner side than upon the outer.'—[Ed.]

[2] *Extract from Note-book.*—'The supra-basilar antler, as a whole, is somewhat concave, the concavity being inwards. When the horn is laid flat, the common plane of the supra-basilar is raised some inches above that common to the median and royal antlers. The section of the supra-basilar is much less flattened than that of the median and royal, the section forming an oval, convex outwards and flattened inwards.'—[Ed.]

an expanse at its tip of about 2½ feet. The lower tyne is broken off at the base, but the fracture indicates that it must have been nearly equal in size to the other, with a downward inclination. All three tynes are in the same vertical plane, forming a three-pronged fork. This plane does not correspond with that of the divisions of the supra-basilar, which, as already stated, inclines more outwards.[1]

The third or royal antler is given off about 10 inches above the median, like the others, in a flattened branch, which slopes upwards, and after a stretch of about 5 inches bifurcates. The lower snag, the tip of which is wanting, is of great length; it is directed forwards, with a slight inclination upwards, so as to be nearly parallel with the uppermost snag of the median. The second snag of the royal is broken off a little above the fork; but the remaining portion of its base indicates that it was simple, and that its point was directed nearly straight upwards, or in a line with the axis of the beam. The expanse of the broken end of the lower snag of the royal, measured from the posterior edge of the beam, attains not less than 2 feet 5 inches, and when the terminal portion was complete it can have been but little short of 3 feet, while the entire length of the beam from the bur to the terminal fork does not exceed 1 foot 10 inches. The vertical plane of the royal and its branches, as already stated, corresponds with that of the median.[2]

The terminal part of the beam is broken off immediately above the edge of the royal antler; but a portion of the fork between them remains. The width of the terminal portion of the former does not exceed that of the larger snag of the latter. It is therefore inferred that the beam was continued up in a single very elongated slender snag; or there may have been a fork of two snags. Detached specimens of very elongated, straight, slender snags, compressed at their base, and from the same Forest-bed, exist in the collections of the Rev. John Gunn and of Mr. Fitch of Norwich, one in each. These would correspond with the supposed termination of the beam, in the specimen here described.

[There is no conclusive indication as to how the beam terminated, but Mr. Gunn has got in his collection a magnificent fragment of a flattened antler, the channelled surface and general appearance of which correspond very closely

[1] *Extract from Note-book.*—'The median is very much flattened, the section of the oval being 3½ by 1¾ in.'—[Ed.]

[2] *Extract from Note-book.*—'The royal is still flatter than the median, the section being 4⅝ by 1¼ in., and the successive tynes are flattened in a similar manner, as we go upwards, the lower tyne of the royal at the middle being 3 inches by 1.'—[Ed.]

with the characters of the large horn. This fragment, although the terminal portion of the longest tyne is broken off, measures upwards of 25 inches. The basal portion stretches along a length of about 11¾ inches, maintaining uniformly nearly the same diameter. It is somewhat flattened, the section near the middle being 2½ × 1½. At 10 inches it gives off a snag or small tyne, the section clearly showing that it was of no considerable size. The remaining portion of the tyne, which continues the beam above the fork of the small tyne, is no less than 14¾ inches long, although a considerable portion of the point is wanting. When perfect this tyne could have been little less than 20 inches in length. It is continued nearly straight upwards, irregularly conical and but very little compressed.

This fragment is boldly channelled with broad shallow grooves.—H.F., *Oct.* 3, 1863.][1]

The following are the principal dimensions:

Length of pedicle (*a c*) 2½ in. Diameter of bur (*a a*), 3 in. Breadth of bur, ½ in. Girth of beam at base of pedicle, 8¼ in. Ditto ditto above bur, 8½ in. Length of beam from bur to terminal fork of royal antler (*a b*), 24½ in. Ditto to inferior edge of supra-basilar (*a d*), 4½ in. Length of beam from bur to fork of supra-basilar (*a e*), 6 in. Length from upper edge of supra-basilar to upper ditto of median (*e i*), 8¾ in. Length of beam from median to terminal fork (*i b*), about 14 in. Width of supra-basilar (*d e*), 2½ in. Ditto of ditto at greatest constriction, 2½ in. Ditto of beam between ditto and median (*f g*), 3¼ in. Width of median (*h i*), 3½ in. Width of beam between median and royal (*j k*), 3½ in. Width of royal (*m l*), 4½ in. Breadth from posterior edge of beam to main fork of supra-basilar (*n o*), 10 in. Ditto ditto to 2nd upper fork (*n p*), 12¾ in. Ditto ditto to 2nd snag of supra-basilar (*n q*), 16 in. Ditto ditto to main fork of median (*r s*), 13¼ in. Ditto ditto to 2nd fork of ditto (*r t*), 18 in. Ditto ditto to 2nd snag of ditto (*r u*), 29 in. Ditto ditto to fork of royal (*v w*), 11 in. Ditto ditto to broken point of 1st snag of ditto (*v z*), 28 in.

The horn above described is evidently of an adult animal, but not of the maximum size which the species attained. Besides specimens in Mr. Gunn's collection, there are in the Norwich Museum two basal fragments of shed horns, each including the offset of the supra-basilar antler, presented by the Rev. Mr. Foulger. They are both of larger size than the corresponding parts of Mr. Gunn's specimen. One measures 7 inches from the bur to the fork at the offset of the supra-basilar antler, with a girth of 8¼ inches above the bur; the other measures 7½ inches to the fork, with a girth of 7½ inches. In all these instances, one important specific character is constant, namely, that the basal portion of the beam is straight and cylindrical, and without a trace of brow- or bez-antler. In Mr. Gunn's collection, besides detached snags,

[1] Mr. Gunn believes he has succeeded in fitting this terminal portion of the beam to the antler, and through his kindness it is included in the annexed drawing. Plate xxxvii. *x y*.—[Ed.]

there are some large fragments of the upper and dilated portion of the beam, which by their curves, constriction and expansion, and fluted pattern, agree closely with corresponding parts of the large specimen here described. They all indicate horns of great size and massiveness, and hence a very large species.

The next point to ascertain is the frontal insertion and direction of the horns. The well-developed pedicles, straight butts, and absence of obliquity to the bur, distinguish the species from all other large forms of Deer, fossil or recent, in which the horns are sessile as in the Reindeer and Elk, divergent from the sides of the skull as in the latter, or reclinate with oblique insertion as in the Irish Elk. The butt of the beam is continued in the same line with the pedicle, as far as the offset of the lowermost antler. It is therefore clear that the horns were reclinate as regards the head, and slightly divergent after the fashion of the Rusa group or *Hippelaphine Deer*.

Of the skull, which it so materially modified, in some of the recent and extinct species of Deer, I know of no specimens that can with certainty be referred to the form here described. Mr. Gunn possesses, in his rich collection at Irstead, mutilated skulls destitute of the facial portion of at least three, if not four, large species of extinct Deer from the 'Forest-bed,' but the large horn cannot be referred with confidence to any one of the forms in particular.[1] I have

[1] *Memoranda of Crania of Cervus in Mr. Gunn's collection, made by Dr. Falconer for Mr. Gunn, Oct.* 3, 1863.—No. 20.—The most perfect is a cranial fragment comprising both frontals, part of both orbits, the left superciliary foramen, both horned pedicles, the anterior portion of both parietals, and the greater part of the cerebral cavity. The open condition of the parieto-frontal suture and of the sagittal suture proves the individual to have been young. The basal portion of the horn is present on both sides, but most perfect upon the right. The horned pedicles are very short and divergent. There is a fracture in front at the base of the right horn immediately above the bur, which would appear to indicate that a brow-antler was given off immediately above the bur. The insertion of the beam is very oblique, the bur exhibiting an inclination somewhat like that of the Irish Elk. There are two shallow depressions on either side of the sagittal suture (one on each side), bounded outwards by the secondary superciliary foramina. The species must have been as big as the *C. Hippelaphus*. The horned pedicles are very short, and the interval between the orbits and the pedicle is inconsiderable. There is no lateral fossa between the bur and the orbits. The dimensions are:—Width of frontal above the orbits, 7· in. Vertical diameter of the bur (right side), 3·20 in. Interval between the two horns, measured at bur, 4·30 in. Girth of right pedicle, 8¼· in.

I am unable to refer this specimen to any in the British Museum or in France. It appears to differ from the Deer of Auvergne and Chartres.

No. 21.—Another specimen in Mr. Gunn's collection is very much like the last, but with a larger portion of the horn preserved on both sides. The specimen is about the size of *C. elaphus*. The horns are much less divergent than in the previous specimen. Each shows a fracture in front, a little above the bur, indicating the offset of one, or two, brow-antlers. It is impossible to say which. The horn is terete and suddenly reclinate backwards. This specimen may correspond

seen also, by the aid of the Rev. S. W. King, a skull in the possession of Mr. Sandford, junior, of Cromer, procured from the 'Forest-bed' of Sidestrand. It consists of the greater part of the cerebral part of the skull of a very large species of Cervus, which, from the form and insertion of the pedicles, I think it highly probable belonged to the same species as the Bacton horn.[1]

None of the established sub-genera groups of *Cervus*, founded conventionally on the characters yielded by horns, will admit the fossil species.[2]

[During the last two years of his life, Dr. Falconer devoted much attention to the fossil remains of the genus Cervus, and his Note-books contain numerous references to specimens which he had examined in the various palæontological collections of England and the Continent. Although in most instances the descriptions are too fragmentary to merit publication, it may be interesting to refer to some of the identifications to which the author was led. The most important are as follows:—

1. September 20, 1858.—In Col. Wood's collection at Stouthall from the Gower Caves. (See p. 498.)

a. Cervus euryceros. Molars, but no determinable fragments of antlers.

b. Cervus Tarandus. Crania from Paviland and Spritsail-Tor.

with some of the species figured by Croizet, but I am unable to make it out. It deserves to be figured as well as the previous one.

No. 22.—A third specimen consists of the frontals, cerebral cavity, and both horned pedicles, but both horns shed, so that the distinctive characters are wanting. The horned pedicles are short and slightly divergent, and the frontal plane above the nasal suture shows a prominent mesial ridge, bounded on either side, first by a depression and then by a bulge outwards for the superciliary artery. Laterally, below the horned pedicle, there is a deep depression.

The form and characters remind me strongly of some of the St. Prest specimens, which Lartet and I saw at Chartres.

The dimensions are:—Width of brow between orbits and pedicle, 6½ in. Girth of horned pedicle, 8½ in. This specimen ought also to be figured. It appears to have come out of the iron pan of the Forest-bed.

No. 23 is a specimen corresponding with the three last, but terribly weathered and rolled.

On the right side the pedicle bears a horn, which differs from the others in the collection by emitting a brow-antler, which is directed inwards, but is so rolled that nothing can be made out of it, except that the species differs from the three others above referred to.

[1] *Extract from Note-book.* 'British Museum, Aug. 5, 1863.—No. 82,497 is a magnificent skull of a Deer, dark and heavy, and evidently a dredged specimen. It shows the whole of the occiput, condyles, and basal portion, and also part of the frontal and of the two orbits. It is of the size of the Irish Elk, but is of a different species. The form of the occiput and the offset of the horns are different, and the distance between the base of the horn and the orbit is much longer. Can this be the species to which Gunn's horn belongs?'—[Ed.]

[2] From entries in Dr. Falconer's Note-books it appears that after careful comparison with the remains of deer in the British Museum, and in the Museums of Paris, Le Puy, and Chartres, he was unable to identify the fossil with any species hitherto described. At one time he was inclined to think that it might belong to *Cervus martialis* (Gervais), but this opinion he ultimately gave up, and, as Mr. Gunn informs me, *C. martialis* had a brow-antler.—[Ed.]

c. Cervus Guettardi (Desmarest). 'A complete series of eighteen or nineteen specimens of different ages, all limited to basal portion of antler. They agree exactly with the specimens originally figured and described by Guettard, and reproduced by Cuvier in the "Ossemens Foss." *Cerfs*, Pl. VI. figs. 14 to 17. They differ entirely from figs. 10, 11, and 12 of the same Plate, which Cuvier conjectured might belong to a different age of the same species. As this is the form of antler that was originally described by Guettard, it is but right that the specific name of *Cervus Guettardi* should be restricted to it.'

d. Cervus priscus? Two antlers which agree exactly in form with figs. 11 and 12 of Plate VII. *Cerfs*, of the 'Ossemens Foss.' from Étampes, found along with *C. Guettardi.*

e. Cervus Bucklandi? One specimen comprising the basal part of the horn, bur, and offset of bez-antler.

f. Cervus Elaphus. Antlers.

g. Cervus Capreolus. Several small specimens, some of them bearing knife marks.

h. Indications of two other species not identified.

2. April, 1859.—In Signor Ceselli's Museum at Rome, examined numerous antlers of *Cervidæ*. One fine specimen appears to belong to *C. intermedius*, 'but saw nothing in the least degree approaching Rein-deer.'

3. May 14, 1859.—'In the Museum at Bologna is a very interesting skull of Irish Elk from the Val di Chiana, comprising the cranial portion with part of both horns, showing the cylindrical beam, the stumps of brow- and median antlers, and the palmate expansion on the left side.'

4. May 27, 1859.—'Saw in Massolongo's collection at Verona the lower half of the horn, from bur to commencement of palmation, of the Italian form of the Irish Elk, exactly like the Val di Chiana specimen in the Bologna Museum, also a portion of the cranium noted in the Catalogue as being "Corno giganteo e pezzo di cranio di Cervo fossile raccolto nei terreni del Veronese."'

5. September 27, 1862.—In Mr. Grantham's collection at Erith, a typical specimen of a shed antler of *Cervus Elaphus*, and a fine specimen of an antler nearly to fit *Strongyloceros spelæus.*

6. September 30, 1862.—In Dr. Spurrell's collection at Belvedere, numerous specimens of *Cervus Elaphus*, one nearly big enough to pass muster for *Strongyloceros spelæus*: a very doubtful fragment of Rein-deer antler (probably *C. Elaphus*); but no other indication of Rein-deer, or of any other species of Cervus.

7. July 20, 1863.—In Mr. Wyatt's collection at Bedford, shed antlers of *Cervus Elaphus*, from Summerhouse Hill; and antlers of *Cervus Tarandus*, from Howard's Field, Bedford, and from the Gravel, Bleston.

8. August 13, 1863.—In Mr. Prestwich's collection from railway-cuttings at Bedford, remains of *Cervus euryceros*, or Irish Elk; *Cervus Elaphus*; and *Cervus Tarandus*, or Reindeer.

9. September 8, 1863.—In Brown's Clacton collection in the British Museum is a very extensive series of Deer horns, nearly all belonging to one species. They are all terete, with a single brow-antler given off very low, as in the Val d'Arno Axis, but a little lower and pointing more forwards above the brow-antler. There is generally a long reach of beam with no branch. How the beam terminates is not shown. In

size it is like Mr. King's Axis from the Crag and Forest-bed, but it differs in the brow-antler being given off lower, and in not having the same pronounced double curve. The species is evidently distinct (*Cervus Clactonianus*).

10. September 12, 1863.—'Jardin des Plantes, Paris. Examined, with Lartet, Cuvier's horn of *Cervus Somonensis* (Oss. Foss. tom. iv. Pl. VI. fig. 19). A small part of the frontal is present. There is absolutely no pedicle whatever, and the horn base is very close to the orbit. The summit is united with plaster and is evidently a misfit, probably not even of the same species, or certainly turned the wrong way. Very puzzling to determine the species.'

11. September 15 to 21, 1863.—Dr. F. visited the Museums of Le Puy and Chartres, in conjunction with M. Lartet, and took numerous notes and drawings of the fossil remains of Deer found in them, and particularly of *Cervus Solilhacus* and *C. Polignacus*, but he failed to discover any specimens resembling the large antler in Mr. Gunn's collection.

12. September, 1863.—Provisional list of Norwich-Crag and Forest-bed *Cervidæ*.

a. Mr. Gunn's large *Cervus Sedgwickii*. (See *antea*, p. 472.)

b. Mr. Gunn's large *Strongyloceros* (*sic*). The specimen is of left side, and consists of the basal portion of a huge horn that had been shed. The brow-antler is given off about 2 inches above the bur, and is curved abruptly downwards and outwards like a huge hook; it is perfectly terete, and the portion remaining shows no appearance of sub-division. It is very boldly channelled on the convex outer side; smooth inwards. The beam above the bur is not quite terete, but oval, with a ridge behind, opposite the brow-antler. The beam then contracts, and becomes nearly cylindrical, and then expands, giving off from the anterior outer side a large antler, at about 6–7 inches above the bur and 4½ inches (lower edge) above upper side of brow-antler. The beam is then somewhat flattened in a direction corresponding with that of the brow-antler. Only the section of the base of the median antler seen. A ridge descends from lower edge of median antler, outer side, to the ridge or tuberosity opposite the brow-antler.

Length of specimen, 13·5 in. Girth above bur, 10·5 in. Girth of brow-antler at base, 7·5 in. Ditto at tip, 6· in. Length of brow-antler fragment, about 5· in. Vertical length of section of median, 2·5 in. Transverse diameter of ditto, 2·0 in. Girth above brow-antler, 8·25 in. Ditto above median, 9·5 in.

The brow-antler is given off much higher than I have ever seen it in the Irish Elk; the beam less cylindrical than in the latter, and more erect, without the elegant long reclinate reach in the latter. The low offset of the median antler is also very different. It appears to indicate a huge Deer as large as Irish Elk, but quite distinct.

There is nothing like it in the British Museum.

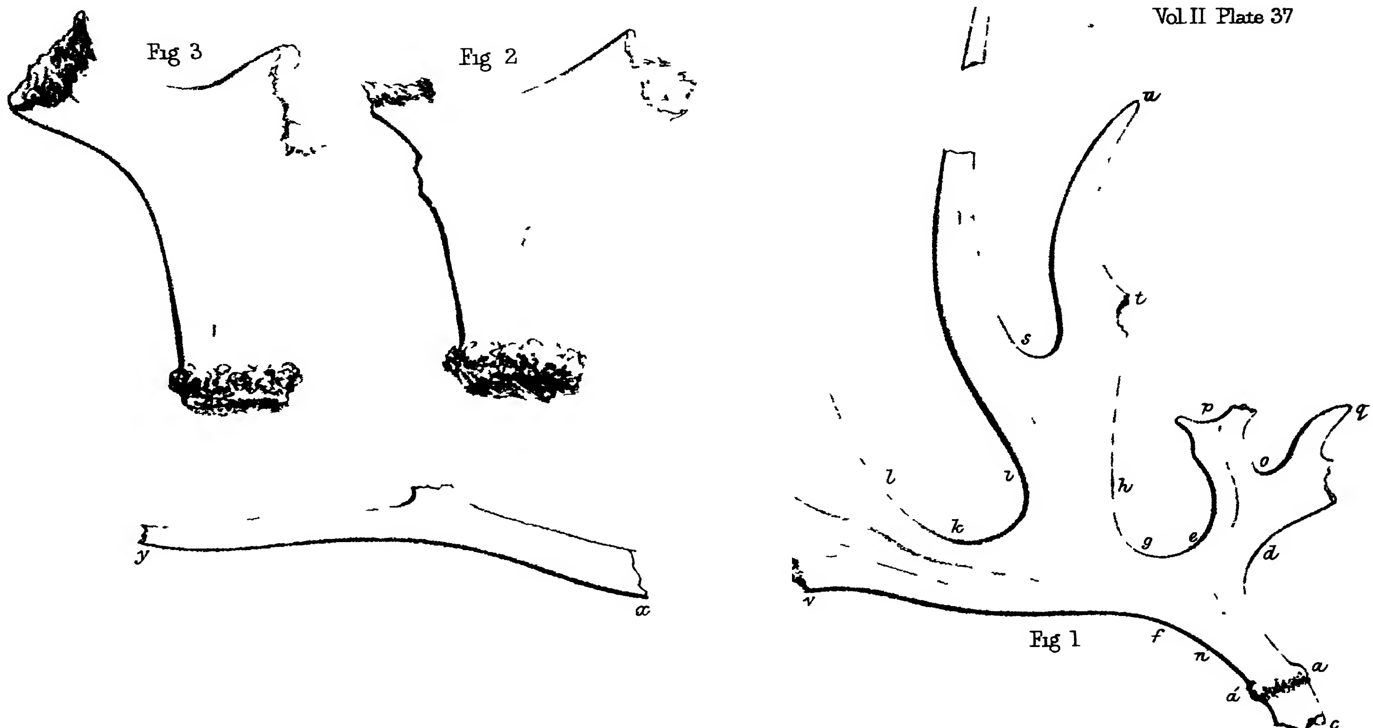
c. Mr. Gunn's large *Cervus Polignacus*—'a shed-antler throwing off a brow-antler, which nearly continues the beam downwards; the beam deeply channelled, round below and flattened a little above; evidently the same species as the Val d'Arno figures.'

d. *Cervus eurycerus*, from Miss Anna Gurney, in Oxford Museum (1858).

e. The Rev. S. W. King's specimen of *Rusa*. This is a double curved

horn. It not only curves backwards, but also (with a slight tendency to twist) outwards. The specimen includes part of the frontal with the cerebral cavity, but no part of the orbit. The bur is very salient and pronounced as in *C. Elaphus*. The beam at the base is nearly level, with a tendency to keel between the bur- and the brow-antler, and deeply channelled. The beam above the brow-antler is nearly terete, and there is a well channelled offset of the supra-basilar about 1·3 inch above the bur. The dimensions are: Ant.-post. diam. of beam at bur, 1·5 in. Transverse ditto, 1·4 in. Transverse diam. above bur, 1·5 in. Ant. post. ditto, 1·25 in. Height to top of fork, 2·5 in. In the Museum of the Jardin des Plantes there is an antler (No. 6,201) from the Val d'Arno, labelled *C. Arvernensis*, which is twisted exactly like Mr. King's.

f. British Museum specimen of *C. Dama* (No. 27,876 ?).
g. " " Axis.
h. " " an Elaphoid form of Cervus, but not *C. Elaphus* (No. 33,471 ?).—Ed.]



Cervus (Eucladoceros) Sedgwickii

T Dinkel lith.

W West imp

XVI. NOTE OF AN UNDESCRIBED SPECIES OF BOS IN THE FLORENCE MUSEUM (BOS ETRUSCUS?)[1]

FLORENCE, May 20, 1859.—I examined in the collection in the Grand Ducal Museum the entire skull of a Bovine ruminant, to which the lower jaw is attached. It is a good deal crushed laterally, and in the frontal portion between the horns it bears a loose ticket, on which is inscribed '284, *Bos bombifrons*' of Nesti; but I suspect that there is an error or misplacement in the ticket, as there is no appearance of any protuberance of the brow. The frontal plane extends a considerable way behind the offset of the horns, showing the two temporal fossae, which at their termination approach close together, with an interval of only $2\frac{1}{2}$ inches. This posterior extension of the frontal plane is much greater than what is seen in *Bos priscus*, and differs entirely from the overhanging crest of *Bos primigenius*. The horn-cores are cylindro-conical and slender, and of considerable length; they stretch backwards and outwards with a gentle curve, nearly in the same plane as that of the brow, their convexity being outwards, something like in domestic cattle. They are $22\frac{1}{2}$ inches apart at their tips, with well defined pedicles at their base. The dimensions are as follow:—

Length of right horn-core measured along the outer curve, about $20\frac{1}{2}$ inches. Girth at base, $9\frac{1}{2}$ in. Length of skull from occipital crest to tips of incisive bone, $20\frac{1}{2}$ in.

The form of the brow, occipital crest, and temporal fossae, the direction of the horns, and the size of the skull appear to distinguish this animal very remarkably from *Bos primigenius* and from *Bos priscus*. It is also of very much smaller size, and I suspect constitutes a distinct undescribed species, for which the designation *Bos Etruscus* would be appropriate. The name *Bos bombifrons* must be a misnomer, and was probably applied by Nesti to *Bos priscus*.

In the same collection there are four cranial fragments of *Bos priscus*, of very large size. They all consist of the frontal tablet, behind the orbits, and each of them bears the horn-cores having the usual direction seen in this species, *i.e.* stretching out horizontally, with the tips slightly curved forwards. In the largest specimen the constriction of the brow behind the orbits measures $11\frac{1}{2}$ inches, and the interval between the tips of the horns 36 inches. The collection also contains three cranial fragments of *Bos primigenius*, which, as well as those of *Bos priscus*, are all labelled as coming from the Val di Chiana. They are very fresh looking, and are evidently from a more recent deposit than the old Val d'Arno specimens. The skull marked '*Bos bombifrons*' is well fossilized, and all the molar teeth are out.

[1] Extracted from Dr. Falconer's Note-book.—[ED.]

XVII. NOTE UPON CRANIA OF CROCODILUS CATAPHRACTUS, AND CROC. MARGINATUS, IN THE BELFAST MUSEUM.[1]

THE existing Crocodiles are still but imperfectly defined, and there is little agreement among systematic authors regarding the number and characters of the species. This remark applies with especial force to the Crocodiles of the Nile and of the Ganges. Geoffroy assigns five species of true Crocodile to the Nile, all of which are considered by Cuvier as varieties of a single species, *C. vulgaris*. Dumeril and Bibron, in their 'Erpétologie,' published in 1836, follow the view taken by Cuvier, although it would appear from a verbal communication of M. Bibron, that their opinions have been considerably altered since Mr. J. E. Gray, in his 'Synoptical Catalogue,' published in 1844, admits two species, *C. vulgaris* and *C. marginatus*. In like manner, the Crocodiles proper of the Ganges were restricted to a single species by Cuvier, *C. biporcatus*, in which view, also, he is followed by Dumeril and Bibron, although *C. palustris* of Lesson is inserted with doubt as a variety of *C. vulgaris* in their systematic work; but it would appear from the labels of the specimen in the Paris Museum, that they now recognize it as a distinct species. On the other hand, Mr. Gray gives three species to the Ganges, viz., *C. biporcatus*, *C. palustris*, and *C. bombifrons*. It is of interest therefore to record the existence of any specimens bearing upon the disputed or ill-determined species; and

[1] This memoir was communicated by Dr. Falconer to the British Association at Southampton in 1846, and is reprinted from the Ann. and Mag. Nat. Hist for Dec. 1846, vol. xviii. p. 361, where it appeared with the following note:—'Communicated by Mr. W. Thompson, President of the Society to which the Museum belongs, with the following remarks:-The crania which form the subject of the present notice were presented to the Natural History and Philosophical Society of Belfast by Dr. McCormac, of that town. They were taken in the waters of the Sierra Leone river or its tributaries, and given to that gentleman by his brother, Mr. John McCormac, of Freetown, Sierra Leone. My friend Dr. Falconer, on visiting the Museum with me early in 1845, called my attention to the rarity of these crania. On leaving home for London, a few months afterwards, I took the specimens with me for the purpose of comparison with others in the collection there, and the result is set forth in the paper. To the kindness of Mr. Grattan (Treasurer to the Society already named) we are indebted for drawings of the specimens made by means of a camera-lucida. These, for the sake of comparison with the figures in Cuvier's 'Ossemens Fossiles," have been drawn of the same size.'—[ED.]

having observed the crania of two rare Crocodiles in the Museum at Belfast, the following notes regarding them have been drawn up by me at the request of Mr. W. Thompson.

I. *Crocodilus cataphractus*, Cuv., Oss. Fossiles, tom. v. p. 58, Pl. V. figs. 1 and 2; Dum. and Bibron, Erpét., tom. iii. p. 126; *C. leptorhynchus*, Bennett, Proc. Zool. Soc. 1835, p. 129; *Mecistops Bennettii* and *M. cataphractus*, Gray's Catalog., pp. 57 and 58.

This species was founded by Cuvier upon an imperfect specimen of unknown origin in the Museum of the London College of Surgeons. It was briefly described by Bennett, first as a distinct species from Fernando Po, in 1835, and afterwards as a variety of *C. cataphractus*, in the 'Zoological Proceedings' of 1836. Mr. Gray has erected it into a separate genus under the name of *Mecistops*, in which he includes along with it the *C. Journei* of Bory de Saint-Vincent, and *C.* (*Gavialis*) *Schlegelii* of Muller. So far as is known to us, no representations have yet been given of the cranium divested of its integuments. Plate XXXVIII. figs. 1, 2, and 3, represent the Belfast specimen, viewed from the top, base, and side of the skull. It is evidently identical with Gray's *Mecistops Bennettii*; the head of the stuffed specimen of this nominal species in the British Museum collection agreeing with it exactly in form, and very nearly in size. The muzzle is more attenuated and narrower than in *C. acutus*, but less so than in *C. Schlegelii*, which constitutes the passage from the true Crocodiles into the Gavials. The cranial tablet is not so wide as in the Gavial, *C. Schlegelii*, and the crotaphite foramina are proportionally smaller. The muzzle does not contract abruptly in front of the orbits, but is gradually attenuated from the back part of the cranium forwards. The extreme width at the condyles of the lower jaw is 7 inches, behind the orbits $4\frac{3}{4}$ inches, and in a line with their anterior border $3\frac{1}{2}$ inches. At the seventeenth or last tooth of the upper jaw the width is $3\frac{5}{8}$ inches, and $1\frac{3}{4}$ in. between the eleventh and twelfth teeth; there is an expansion to 2 inches opposite the ninth tooth, which is the largest in the head: thence the beak contracts gradually to the space between the fourth and fifth teeth, where the width is only 1 inch; at the extremity of the muzzle, between the second and third teeth, it expands to $1\frac{3}{4}$ inch. The margins, when viewed in plan, are therefore more undulated and less cylindrical than in the Gavial or *C. Schelegelii*, and there is less dilatation on the point of the beak.

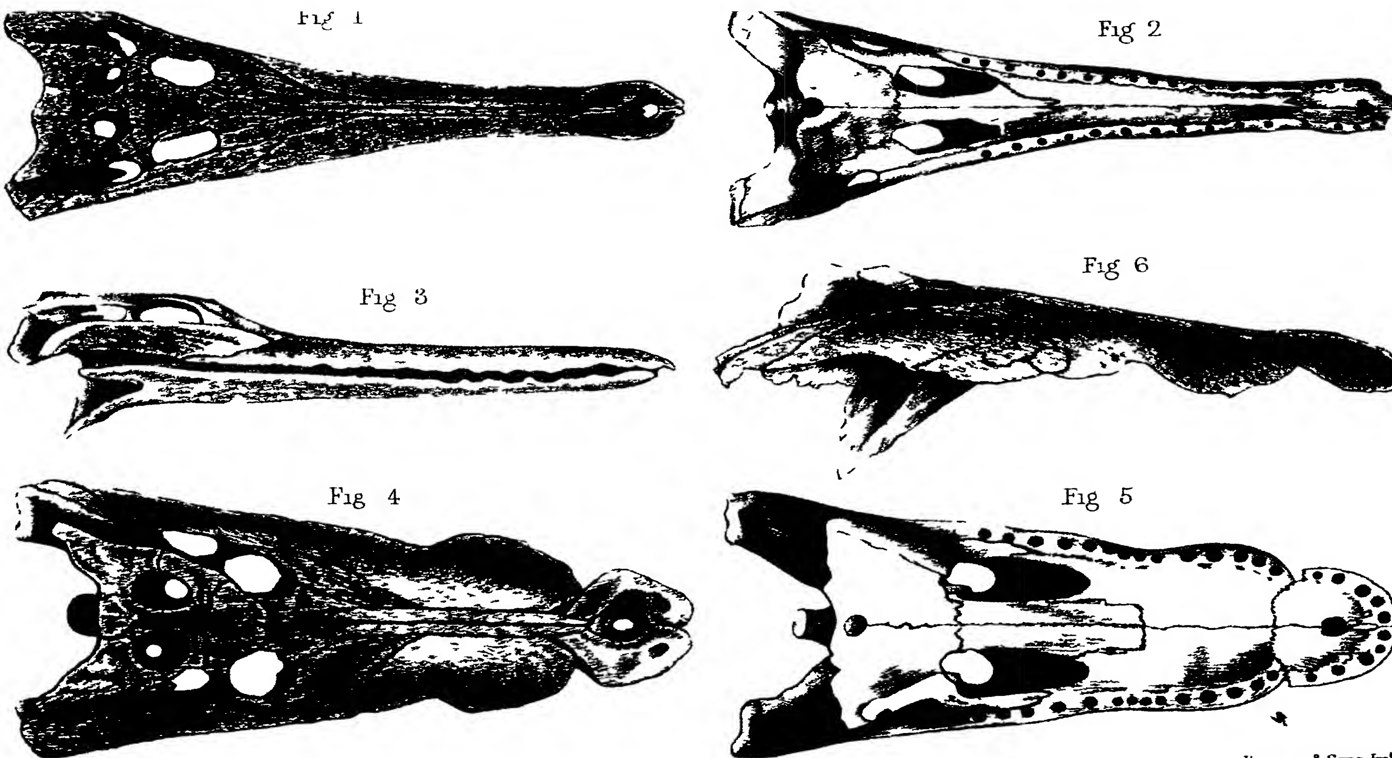
The orbits are much larger than the crotaphite foramina, which are separated only by a narrow interval; while in the Gavial they are large and wide apart. The lachrymals form

narrow slips of bone, which descend upon the nasals a considerable way below the anterior margin of the pre-frontals. The nasal bones are extremely narrow and attenuated, but, as in the true Crocodiles, they descend between the maxillaries so as to project into a niche between the intermaxillary bones. The same holds good in *C. Schlegelii*; whereas in the Gavial the nasals terminate a short way in front of the orbits, and do not enter into the formation of the anterior portion of the beak. This character is a good diagnostic mark between the Crocodiles proper and the Gavials; separating *C. Schlegelii* from the latter subgenus under which Muller has ranged it. The nasal opening is smooth, oval in form, and of moderate size. There are seventeen teeth in the upper jaw, and fifteen in the lower; the largest teeth in the upper are the third and ninth; in the lower, the first, fourth, tenth, and eleventh. The dimensions are subjoined.

II. *Crocodilus marginatus* (?), Geoff. Croc. d'Égypte, 165, and Gray's Catal. Brit. Mus., p. 61; *C. vulgaris*, var. C., Dumer. et Bibr. Erpétolog., iii. p. 110; *C. vulgaris*, Cuv., Annal. du Mus., tom. x. 40.

The Belfast specimen is doubtfully referred to this species, there not being sufficient materials in the London museums to admit of a satisfactory determination. Neither the College of Surgeons' collection nor the British Museum is possessed of an adult cranium of the common Crocodile of the Nile, *C. vulgaris*, or of *C. marginatus*, although there are numerous stuffed specimens attributed to both species in the British Museum collection. The comparison of the Belfast specimen has in consequence been limited to the reduced figure of the skull of *C. vulgaris* in the 'Ossemens Fossiles.'

The cranium is 19 inches long, and must have belonged to an adult animal. The principal distinctive character assigned to *C. marginatus*, both by Geoffroy and by Dumeril and Bibron, in addition to the form of the nuchal and dorsal scutes, is that the borders of the cranial tablet are raised, while in *C. vulgaris* the frontal area is perfectly flat. In the Belfast cranium these lateral margins are also considerably elevated, and the following points of difference from *C. vulgaris* are besides observable. The facial portion of the head is less elongated in proportion to the cranial, and more obtuse than in *C. vulgaris*; the interval between the orbits is greater; the crotaphite foramina are relatively larger; the lachrymals are narrower, and descend further upon the nasals; the muzzle is considerably blunter, and the niche for the reception of the fourth tooth of the lower jaw is larger, causing a greater amount of constriction. The general outline of the muzzle, instead of being acute and subcuneiform, is obtuse and oblong,



1 2 3 Crocodilus cataphractus 4 5 6 Crocodilus marginatus

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somewhat resembling the form of *C. palustris* of the Ganges. There is also a marked constriction behind the twelfth tooth, considerably greater than in *C. vulgaris*. The largest teeth are the third, the fourth, and the tenth, the last being the largest of all. The nasal aperture is more circular than in *C. vulgaris*. There is no lower jaw to the Belfast specimen. Plate XXXVIII. figs. 4, 5, and 6, represent the cranium, viewed from the top, palate, and side, as in *C. cataphractus*.[1]

The dimensions of the cranium are as follow:—

Dimensions	C. cataphractus	C. marginatus.
	In.	In.
Length of cranium from the point of the muzzle to the occipital ridge	15·5	16·
Length of cranium from the point of the muzzle measured to condyle of the upper jaw	17·	19·
Extreme width of cranium at the condyles	7·	8·5
Length from occipital ridge to base of nasals	6·	6·7
Length from the point of the muzzle to base of nasals	9·	10·7
Length of orbit	1·8	2·7
Width of orbit	1·4	2·
Interval between orbits	·8	1·5
Antero-posterior diameter of crotaphite foramen	1·1	1·9
Transverse diameter of crotaphite foramen	·8	1·4
Width of the muzzle at the last tooth	- -	6·7
Width of the muzzle at base of the nasals	2·8	6·5
Width at contraction behind the twelfth tooth	—	4·8
Width at the tenth tooth	- -	6·8
Width at the ninth tooth	2·	—
Width at contraction behind the fourth tooth	1·1	
Greatest contraction behind fifth tooth	- -	2 9
Dilatation of the point of the muzzle	1·8	4·3
Length of the nasal aperture	·9	2·
Width of the nasal aperture	·75	1·8
Length of intermaxillaries on the palate	3·	3·9
Length of maxillaries on the palate	6·3	4·1
Antero-posterior diameter of palatine foramen	—	4·7
Transverse diameter of palatine foramen	—	1·9[1]

[1] Part of the above description, taken from Dr. Falconer's Note-books, was published in vol. i. (p. 356), before I was aware of the existence of the above memoir. In reference to three species of Crocodiles of the Ganges mentioned at p. 355 of vol. i., *C. bombifrons*, according to Dr. Falconer, occurs in the northern branches of the Ganges, 1,000 miles from Calcutta; *C. biporcatus* appears to be confined to the estuary; and *C. palustris* to range from the estuary to the central parts of Bengal. The Gavial is found along with *C. bombifrons* in the North, and descends to the region of *C. biporcatus* in the estuary. (See Sir C. Lyell's 'Principles of Geology,' 10th ed. 1867, p. 473.)—[Ed.]

XVIII. ON THE OSSIFEROUS CAVE OF BRIXHAM, NEAR TORQUAY.

[THE great and sudden revolution in modern opinion, respecting the probable existence at a former period of man and many extinct mammalia, has been universally attributed to the results of the explorations of the Brixham Cave. The subjoined documents show clearly in whom this revolution mainly originated. On May 10th, 1858, the annexed letter, respecting the then newly discovered cave of Brixham, was addressed by Dr. Falconer to the Council of the Geological Society, and in consequence of a recommendatory resolution passed by the Council, the Royal Society, on May 13th, gave a grant of 100*l*. towards the exploration of the cave in the manner suggested by Dr. Falconer. Miss Burdett Coutts contributed 50*l*. towards the same object. At Dr. Falconer's suggestion, a committee was appointed to carry the design into effect. The committee consisted of Professor Ramsay, Mr. Prestwich, Sir Charles Lyell, Professor Owen, Mr. Beckles, the Rev. R. Everest, and Mr. Godwin-Austen. Dr. Falconer was entrusted with laying down the plan and giving the instructions upon which the exploration was to be conducted, and the works were carried on under the immediate superintendence of Mr. Pengelly. The fossil remains were identified by Dr. Falconer. On the 9th September, 1858, a report on the progress of the operations, drawn up by Professor Ramsay, Mr. Pengelly, and Dr. Falconer, was submitted to the general committee, and by them was forwarded to the Royal Society, which, from the importance of the results already elicited, voted an additional sum of 100*l*. to prosecute the inquiry. Almost immediately afterwards, Dr. Falconer was compelled to proceed to the south of Europe, on account of his health; but the explorations were continued by Mr. Pengelly. At a meeting of the general committee, held after his death, Mr. Prestwich was requested to draw up a final report embodying the chief results of the exploration. The first report is given here in full, and embodies the important facts determined by Dr. Falconer of the indiscriminate mixture in the Brixham Cave of human industrial remains with bones of Rhinoceros, Hyæna, and other extinct animals.—ED.]

I. Copy of Letter from Dr. Falconer to the Secretary of the Geological Society.

'31, Sackville Street, W., 10th May, 1858.

'*To the Secretary of the Geological Society.*

'Sir,—I solicit the favour of your bringing the subject of this letter under the consideration of the Council.

'It is well known that a great and popular impulse was given to Geology in this country by the well-directed and eminently successful researches of the late Dr. Buckland, on the Ossiferous Caves of England. After the publication of the "Reliquiæ Diluvianæ," the subject in its general bearing was regarded as pretty well exhausted, so far at least as concerned the uniformyit of character in the fossil remains found in the caverns, and their being referable to a single geological period. Since 1823 the interest in the subject has gradually fallen off, and it is probably not overstating the fact to say, that there is hardly a general geological question in which the majority of geologists in this country take less interest at present than in what relates to the Ossiferous Caves. The subject has not advanced *pari passu* with the progress in the investigation of the Upper-Pliocene and Post-Pliocene deposits.

'It is understood that Dr. Buckland, before the close of his valuable life, had intended to bring out a second edition of the "Reliquiæ Diluvianæ," in which some of the questionable views, so earnestly advocated in the original work, would have been greatly modified. But unfortunately the design remained unaccomplished, and the popular opinions in the cave-districts, where collections were amassed, have been mainly regulated by the doctrines embodied in the work as published in 1823.

'The consequences have been thus:—The Tunnel Caves like "Kirkdale," which were the haunts of predaceous Carnivora, and the Fissure Caves like "Oreston," that were filled from above, have been popularly regarded as containing the débris of the same mammalian fauna, and as having been overlaid with their ochreous loam by the same common agency at the same period. The contents of the different caverns were thus considered as being in a great measure duplicates of one another, and the exceptional presence of certain forms in one case, and their absence in another, were regarded more in the light of local accidents than as significant of any general source of difference. Hence it followed that more attention was paid to the extrication of the bones, and to

securing good specimens, than to a record of their relative association and the order of succession in which they occurred. The remains have been, in some instances, huddled together in provincial collections—the contents of five or six distinct caves, without a discriminative mark to indicate out of which particular cavern they came. Another consequence has been, that being regarded in the light of duplicates, the contents of some of the most important and classical English caverns have been dispersed piecemeal; and so far as regards them the evil is now beyond remedy.

'My object in this communication is to bring to the notice of the Council an interesting case of a newly-discovered and intact cavern, where the mischief done elsewhere may be partly retrieved, and probably much effected by combined action, well directed.

'Within the last month a new and undisturbed cave has been discovered on Windmill Hill, overhanging Brixham, in the same tract of limestone in which the caverns of Kent's Hole, Anstey's Cove, Chudleigh, and Berry-Head are found. I annex a brief notice of the discovery, cut out of the Exeter "Western Times" of the 10th ultimo. Mr. Everest and myself went to see it on the 17th ultimo. Windmill Hill rises immediately above Bolton Street in Brixham. The limestone strata crop out on the NE. side, where they are very cavernous. A vertical channel, running up the hill, marks the base of a fault, the walls being separated by a seam of about two inches of yellowish loam. Near its base, in quarrying out a foundation for cottages, a concealed cavern was disclosed, blocked up by loam, rubbish, and breccia, on removing which an open cavity was seen, low and narrow at the mouth, but expanding inwards, and presenting the usual characters of the Plymouth Limestone caves. Water percolates from above by a copious drift, and the vault and floor are irregularly coated with stalagmite. On a shelving stalagmite terrace in the interior we saw from a distance a pair of large cervine horns, horizontally embedded in the stalagmite, and I distinguished bones of Hyæna, Bear, Bos, Deer, and Horse, which had been picked out of the breccia. The interior of the cavern is blocked up by stalagmitic deposit, but from the hollow sound yielded on percussion it would appear that there are under-vaultings, as in Kent's Hole. In another direction the stalagmitic flooring descends suddenly in a chasm of undetermined depth. There are two external openings nearly at the same level, a considerable distance apart, which would seem to communicate with the same interior hollow; and it is probable that like Kent's Hole the Brixham Cave is of great extent, with irregular ramifications. As in

other similar cases, the principal deposit of fossil bones may be looked for under the stalagmitic floor not yet touched.

'The strip of hill, in which the openings of the cave are, belongs to Mr. Philip Dyer, of Brixham, of moderate circumstances in the industrial walk of life, who appeared to be quite open to an offer from any quarter to lease the cavern for exploration. Taking into account the vast richness of Kent's Hole in fossil remains, the dispersion of Mr. McEnery's collections, and the grievous fate of the MS. labours of about twenty years of his life, it is submitted to the Council whether there is not a prospect of equal wealth in this promising and adjoining cave of Brixham, and whether the case is not one deserving of a combined effort among Geologists to organize operations for having it satisfactorily explored, before mischief is done by untutored zeal and desultory work.

'The importance of following up a case of this description has been forced upon my attention by some of the results of an examination of the cave-bone collections both in England and abroad, in connection with the investigation of the distribution of the extinct Proboscidea in the European upper tertiary deposits. I have during the last twelve months been more or less occupied with the conditions under which Elephant remains occur in the caves; and having lately returned from a tour, in company with my friend the Rev. R. Everest, during which we have made a reconnaissance survey of the caves in, or cave collections from, the neighbourhood of Bristol, the Mendips, Devonshire, South Wales, Kirkdale, and Cefn, some of the results have appeared of sufficient interest to justify my trespassing on the attention of the Council with this communication.

'Of these I may mention the following:—

'1st. The detection in considerable abundance in certain of the caves of the remains of a species of *Rhinoceros*, equally distinct from the *tichorhine* species of Siberia, and of the Glacial period generally, and from the *leptorhine Rhinoceros* of Cuvier, of the Sub-Apennines, Elephant-bed, and Lacustrine deposits of the Norfolk coast.[1] I have seen nearly the entire series of the upper and lower teeth *in situ* in the jaws, and from one of the caves a considerable portion of the skeleton associated with teeth and cranial fragments. The characters distinctive of this form from the species above referred to are so pronounced and so constant, and the materials so abundant, that I have no doubts on the subject.[2]

[1] Dr Falconer had not at this time distinguished between the true *R leptorhinus* (*R megarhinus*) and *R Etruscus* (See *antea*, pp 314, 348)—[Ed]

[2] Having gone into a detailed examination of the remains I find that the species (*Rhinoceros priscus*) is equally distinct from the existing African species and from *Rh leptorhinus* and *Rh tichorhinus*—H F, *Oct* 20, 1858.

I have designated the species provisionally *Rhinoceros priscus*.[1] The interest of the case is enhanced by its presumable relations to some important late investigations of Monsieur Lartet, to which I shall refer in the sequel.

'2nd. Abundant evidence in all the cave districts of two extinct species of Elephant, viz. *Elephas primigenius* (Mammoth), of the Glacial period, and *E. antiquus*, of the Sub-Apennine period (Norwich Crag and the Astesan). The former commonly associated in the English caves with the *tichorhine Rhinoceros*, the latter with *Rhinoceros priscus*. I have not observed among the cave bones any indication of remains of *E.* (*Loxodon*) *meridionalis*, nor undoubted remains of *Elephas* (*Loxodon*) *priscus*.

'3rd. In one of the caves where the evidence is tolerably conclusive that the bones were washed into a fissure about the same time, the following undoubted association was seen:

Elephas (*Euelephas*) *antiquus*,
Hippopotamus major,
Rhinoceros priscus,

without the admixture, so far as the collection went, of other species of the same genera.

'4th. In other caves, *Elephas primigenius* and the *tichorhine Rhinoceros* were observed, without the admixture of *Elephas antiquus* and *Rhinoceros priscus*.

'5th. In one of the caverns the most important part of the skeleton of one *Elephas antiquus* was found together, supplying a desideratum of the European collections.

'6th. In none of the caves were any specimens observed referable to the *Rhinoceros leptorhinus* of Cuvier, as I regard that species to be limited.

'From what I have seen, I am strongly of the conviction that with our present advanced knowledge the thorough investigation of a well-filled virgin cave in England would materially aid in clearing up the mystery, either of the contemporaneity of the Pliocene Mammalian Fauna with the commencement of the Post-Pliocene Fauna, or of the conditions and association under which the former was replaced by the latter. M. Lartet, in a late communication to the French Academy, has thrown out a suggestion, the importance of which, if well founded, can hardly be overestimated, that the mixed Mammalian Fauna of the Glacial period has been made up of two distinct geographical elements, the one a northern division pushed southwards from Siberia and the north of Europe, consisting of the Mammoth, the *tichorhine* Rhinoceros, the Irish Elk, *Ursus spelæus*, *Bos primigenius*, &c.,

[1] Subsequently *R. hemitœchus*, see *antea*, p. 351.—[Ed.]

the other a southern division projected northwards from Mauritania, through Spain and France, comprising the existing African Elephant, the existing two-horned Rhinoceros (*Rh. bicornis*), the Lion, Panther, two existing Hyænas, Hog, Antelope, Porcupine, &c. M. Lartet affirms that Elephant remains from the Quaternary deposits of Spain, which had been examined by him, belong "indubitablement à l'Éléphant actuel d'Afrique et au Rhinocéros bicorne vivant aujourd'hui dans la partie australe de ce même continent." M. Gervais has described Rhinoceros remains from the Cave of Lunel Viel, under the name of *Rhinoceros Lunellensis*, which he affirms are hardly distinguishable from those of the existing two-horned species, the agreement of the teeth being almost complete.[1] M. Lartet states that certain Rhinoceros molars from Kirkdale exhibit the same line of resemblance.

'I have been induced by these circumstances to bring the case of the new Brixham Cavern to the notice of the Council.

'Your obedient servant,

(Signed) 'H. FALCONER.'

II. REPORT OF PROGRESS IN THE BRIXHAM CAVE.

Sept 9, 1858.

Having lately made a joint inspection of the 'Windmill Hill Cavern,' at Brixham, we think it may be of interest to the London committee to know our opinion of the progress already made in the excavations, and of the probable prospective results.

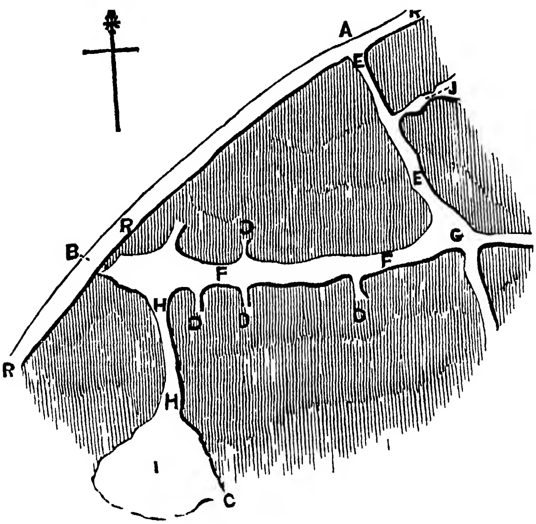
We examined the cavern in company with Mr. Pengelly, F.G.S., under whose zealous superintendence the operations are conducted, and of Dr. John Percy, F.R.S., who during his residence at Torquay has taken an active and lively interest in the exploration. Most of the points to be noticed in the sequel were freely discussed among us, and there was but little difference of opinion as to the bearing of the observations, and the best plan of carrying on the work for the future.

1. *Extent of the Cavern.*—The accompanying ground-plan, by Professor Ramsay (fig. 3), exhibits the extent and ramifications of the cave already ascertained. When the first discovery was made in April of the present year, only the 'Dyer's Entrance' (A), and the 'Reindeer Gallery' (E E), leading in from it in a SS. Easterly direction, were then

[1] See *antea*, p. 309.—[ED.]

known; but another blocked-up entrance, about 25 yards south of the former, and situated at nearly the same level in the cliff, gave promise of further ramifications. This 'Central Entrance' (B), has now been cleared out, and it has been found to conduct into several passages. The principal of these is the 'Flint-knife Gallery' (F F), which stretches inwards with but little tortuosity, from west to east, and intersects the 'Reindeer Gallery' at the 'Ebur chasm' (G), after extending a distance of about eighteen yards. Another

FIG. 3.



GROUND PLAN OF GALLERIES IN BRIXHAM CAVE.[1]

R R, Road. A, Dyer's entrance. B, Central or main entrance. C, South entrance. D D, Subordinate passages unexplored. E E, Reindeer Gallery. F F, Flint-knife Gallery. G, Ebur chasm. H H, Pen Gallery. I, Big Chamber. J, Steep Slide Hole.

passage leads from the same opening, nearly from north to south, for a distance of about ten yards, forming the 'Pen Gallery' (H H), and terminating in the 'Big Chamber' (I). This expansion of the cavern is at present unexplored, but it appears to be connected with a third external opening, forming the 'Southern entrance' (C). There are therefore already three ascertained external openings, connected by intersecting galleries, and all included within the terms of the lease held on behalf of the committee.

[1] This is the 'reconnaissance sketch' which accompanied the Report. Detailed plans and sections were subsequently prepared by Mr. Bristow, of the Geological Survey.—[Ed.]

The general structure of the cavern is now distinctly intelligible. A road (R R) runs along the outcrop of the strata from NE. to SW., a little below the level of the openings A and B. The 'Reindeer Gallery' (E E) corresponds with a line of vertical dislocation, perpendicular to the strike of the strata, and the 'Flint-knife Gallery' (F F) to a series of intersecting tunnel-shaped passages, joining on the former. From the gallery FF a number of unexplored passages (D D) diverge right and left. This 'Flint-knife Gallery' has an irregularly vaulted low roof, which along the greater portion of its extent is perfectly free from any crust of stalactite, and bears the most distinct marks of having been hollowed out by the long protracted action of running water. The floor of this gallery was formed, nearly throughout, of ochreous cave earth, free from any stalagmitic incrustation upon the surface, while the 'Reindeer Gallery' (E E), terminating upwards in an irregular fissured cleft, abounded both in stalactitic pendicles, and was overlaid by a floor of stalagmite, of irregular thickness. At the 'Ebur chasm' (G), where the two principal galleries intersect, the floor was formed of a thin crust of stalagmite, stretching across an empty cavity, the bottom of which is filled with ochreous cave earth. About the middle of the 'Reindeer Gallery' there is a passage, 'Steep Slide Hole' (J), given off in a north-easterly direction, at a very steep incline, which has been followed down to about 40 feet. The 'Reindeer Gallery' is continued inwards beyond its intersection with the 'Flint-knife Gallery' at (G); but the passage is crammed to the roof with ochreous cave earth, and it remains unexplored. This part of the cavern is expected to yield a rich harvest of fossil bones. Regarded in a general way, the Brixham Cavern may be considered as partaking of the tunnel-character of the Kirkdale Cave, in the 'Flint-knife Gallery,' and of the fissure-character of Kent's Hole and the Gower Caves, in the 'Reindeer Gallery.' No vertical flues ascending towards the summit of the cliff have as yet been detected in the explored parts, such as were found in the Oreston Cave and in Paviland.

2. *Workings.*—The conduct of the excavations was consigned by the London committee to Mr. Prestwich and Mr. Pengelly. The committee, fully impressed with the probability of remains of different periods being met with at different levels in the cavern floor, determined from the outset on working the upper deposits horizontally inwards, as far as might be practicable on the same horizon, and then of working the lower deposits successively in the same manner. In this way they considered that they would avoid the risk

of confounding the remains of different levels, which is apt to take place in excavating cave-bottoms vertically down to the rock-floor, and which has vitiated the results obtained in many other cave explorations, more especially in regard of the contested position of human industrial remains. The excavations were commenced on the 14th July, by Mr. Keeping, of the Isle of Wight, deputed by Mr. Prestwich for the purpose; and they have been conducted with such vigour and success, that within six weeks the stalagmitic floor of the 'Reindeer Gallery,' together with the ochreous cave-earth deposits below it, was entirely broken up, and the floor of the 'Flint-knife Gallery,' explored from its interior termination at (G) to the external 'Central Entrance' (B). The 'Pen Gallery' (H H) was also laid open from its commencement on to the 'Big Chamber' (I); and on a rough estimate, about 1,500 bones were exhumed between the 14th July and the 23rd of August.

3. *Successive Floor-deposits.*—We are able to enter on this part of the subject only in a general way, having taken no precise measurements of the incomplete sections at different intervals in the galleries. Where all the deposits are present, the following section was yielded:

1. Layer of Stalagmite, of irregular thickness.
2. Cave-earth (ochreous) with Limestone Breccia.
3. Ochreous Cave-earth, with comminuted Shale.
4. Rounded Gravel; depth undetermined.

Occasional waterworn pebbles were found mingled with the organic remains in the upper deposit of Cave-earth No. 2. The drip from the roof, in wet weather, is copious in all the fissure galleries (like E E), and the floor in these cases is covered with a cake of stalagmite; while in the intersecting tunnel-gallery (F F), there is little or no drip from the roof, and the surface of the cave-earth is uncovered.

4. *Organic Remains.*—Mr. Pengelly estimates that about 1,500 bones had been exhumed during the first six weeks of the workings. A large number of these, however, belong to skeletons of small animals, like the rabbit and fox, found near the surface. We consider that the great harvest of remains will be found in the low-level deposits, which have not yet been penetrated. Remains of the following animals were identified by Dr. Falconer.

Rhinoceros tichorhinus. Detached upper and lower molars, in considerable numbers, of young and old animals, and an astragalus, bearing distinct marks of superficial gnawing, dug up in our presence.

Bos. Species undetermined; teeth, jaws, and other bones.

Horse. Species undetermined; a few remnants.

Cervus Tarandus. The cranial box of the skull, found near the surface by the owner, on the first discovery of the cave; and a very fine entire antler, embedded superficially in the stalagmite, near the intersection of the galleries E E and F F, over the 'Ebur chasm.' Fragments of antlers of other Deer, species undetermined.

Ursus spelæus. Lower jaws of young and old individuals, with numerous detached canines and other teeth, in fine preservation. A superb specimen of the bones of left hind leg, *comprising the femur, tibia, and fibula, folded together, with the patella and astragalus in situ.* These were found near the 'Ebur chasm,' and the other parts of the skeleton may be looked for when that portion of the cavern is dug up.[1]

Hyæna spelæa. Teeth, fragments of the skull, lower jaws, and other bones.

The above is nothing like a complete list of the animal remains found in the cave; but, considering that the workings have hitherto been restricted to the least productive and superficial deposits, it will suffice to show that the anticipations formed of the cavern were not too sanguine, and that the excavations are well worthy of being followed up vigorously. Some of the results already arrived at are of great general interest.

5. *Human Industrial Remains* (?).—Several well-marked specimens of the objects called 'Flint-knives,' and generally accepted at the present day as the early products of rude Keltic or Pre-Keltic industry, have been exhumed from different parts of the cavern, mixed in the ochreous earth indiscriminately with remains of *Rhinoceros*, *Hyæna*, and other extinct forms. One of these so-called 'Flint-knives' was brought up from the deposit No. 2, from a depth of thirty inches below the superficial Stalagmite No. 1. We failed in detecting evidence that these so-called 'Flint-knives' were of a different age, as regards the period of their introduction, from the bones of the extinct animals occurring in the same stratum of cave-earth, or that they were introduced

[1] In a letter to Mr (now Sir John) Lubbock, dated May 24, 1863, Dr Falconer writes as follows:—'The Report on the Brixham Cave was drawn up by me on Sept. 9, 1858. All the circumstances connected with the entire leg of cave bear—femur, with tibia and fibula folded together, and ball of astragalus partly dislocated—and its position in comminuted shale below the ochreous cave earth, and above a well defined flint implement, were determined by me at Torquay and Brixham on September 2. Mr Pengelly gave us the data. I identified the remains and the flint, and drew the inference that the leg must have been introduced with its ligament at least fresh, after the flint manufactured by the hand of man had been introduced into the lower cave deposit.'—[Ed.]

into the cavern by different agencies. Schmerling discovered in the caves of Engis and Chokier, near Liege, well-marked 'flint-knives' and arrow-heads, mingled in the ochreous mud and gravel with the bones of extinct Mammalia, which, he inferred, had been washed in by the agency of running water; these included *Mammoth*, *Rhinoceros*, and *Hyæna*. Delpon and Jouanet have made corresponding observations as to a similar mixture in the caves of Quercy and Perigord. Marcel de Serres, De Christol, Tournal, and Dumas have inferred the same in numerous caves in the south of France. The attention of Mr. Pengelly has been closely directed to a careful and minute observation of the circumstances of the association in the Brixham Cavern. The results of the exploration of each day are carefully put aside and labelled; and it may be anticipated that data will be arrived at for settling the disputed question of the contemporaneous introduction, or otherwise, of the supposed human industrial objects into the cavern along with the remains of the extinct Mammalia.

6. One result of great interest has already been brought out, namely, the superposition of undoubted remains of the Reindeer, above the so-called 'Flint-knives,' from which the inference arises that the Reindeer continued to be an inhabitant of Britain after the appearance of man in the island. A fine horn of a Reindeer, nearly perfect, from the basal 'burr' to the terminal branches of the beam, and presenting a bez-antler 17 inches long, terminating in palmated snags, was discovered superficially embedded in the stalagmite, close to the 'Ebur chasm'; near the same place a 'flint-knife' was brought up from the ochreous earth, thirty inches below the stalagmite. Professor Owen has noticed the occurrence of Reindeer remains in the 'Ash-hole Cavern,' of Berry Head, explored by the Rev. Mr. Lyte. Dr. Falconer has identified skulls of the same species, found in the Mendip Caverns; and Major Wood, of Stout Hall, has discovered skulls of it, in the caves of Spritsail-Tor and Paviland, in Gower. In these instances there was no indication of their association with man; but in the Brixham Cavern the evidence, so far as it goes, clearly tends to show that the antler in question was one of the latest introductions into the cavern, before the 'Dyer's Entrance' was blocked up by rubbish, and long subsequent to the entombment of the objects called 'Flint-knives.'

7. On the whole, we consider the progress made to be highly satisfactory, and the promise of future result to be so encouraging as to merit the best efforts of the committee to provide the means for following up the excavations. The

grant from the Royal Society, together with Miss Burdett Coutts' liberal donation, however carefully husbanded, will not cover the very moderate scale of expenditure within which the operations are at present conducted, beyond the month of December. A further grant may with some confidence be expected from the Royal Society next summer, but we invite the earnest attention of the committee to devise ways and means to meet the expense of the excavations until then.

(Signed) H. FALCONER.
A. C. RAMSAY.
W. PENGELLY.

Sept. 9, 1858.

III. NOTE BY EDITOR.

[Dr. Falconer's Note-books contain a list of nearly 150 numbered fossils from the Brixham Cave identified by himself, a copy of which has since his death been handed to the committee. Most of these specimens were teeth or fragments of bones of the species mentioned in the above report; but the list also included the remains of *Lagomys*, *Canis Vulpes*, *Putorius*, *Arvicola*, *Lepus*, and the bones of birds. One specimen was 'a superb last molar like that of *Rhinoceros hemitœchus*,' and in another it is noted that there was 'a detached Hyæna incisor along with a worked flint!' In reporting to Dr. Sharpey, the Secretary of the Royal Society, the progress of the Brixham Cave excavations on June 7, 1860, Dr. Falconer concluded as follows: 'The grant of the Royal Society has already fructified richly, in the impulse which the Brixham Cave explorations have given to the whole question of the geological indications of the antiquity of the human race, founded upon industrial objects occurring in old deposits, upon which communications are pouring forth daily from various departments in France by observers of authority.']

XIX. OBSERVATIONS ON THE OSSIFEROUS CAVES IN THE PENINSULA OF GOWER, SOUTH WALES.[1]

1. Introduction.—Object of the Communication to give a Summary of some Recent Observations.

The object of this communication is to submit a summary of the results of some researches with which I have been occupied, during the last three years, in conjunction with my friend Lieut.-Colonel Wood, F.G.S., of Stout Hall, upon the Bone Caves of Gower in Glamorganshire. The caverns in question are numerous, and the details, both palæontological and stratigraphical, are much too voluminous for a single communication. I have in consequence thought that it might be useful to give at once a brief account of the more novel and important results already arrived at. I have the less hesitation in adopting this course, as the Gower caves have already furnished a considerable amount of new information regarding the mammalian occupants of the country, during what may be conveniently called the Cave-period; and they appear to me to indicate with more precision than elsewhere in England the date when the cavern strata emerged above the sea, to become the receptacles of the organic remains that are now found in them.

2. Importance and Extent of Colonel Wood's Gower Collection.

It is incumbent on me to premise, *in limine*, that while solely responsible for the palæontological determinations, and the conclusions therefrom arising, I am indebted to the collections of Colonel Wood for nearly the whole of the fossil materials, bearing on the Gower caves, that form the groundwork of this communication. Colonel Wood has been engaged on excavations in most of these caves in succession, during the last ten or twelve years. He has discovered and

[1] This paper was communicated to the Geological Society on May 30 and June 13, 1860. An abstract of it appeared in the 'Quart. Journ. Geol. Soc.' for November, 1860; but the paper itself has not before been published.—[Ed.]

explored several that were previously unknown; and the very extensive collections of fossil bones which he has amassed, together with his notes and observations, have been placed most unreservedly at my disposal. Therefore, although this memoir has devolved upon me, I am desirous that it should be regarded as embodying our joint labours, and that my friend's long-continued, disinterested, and meritorious exertions in the cause of science should be fully recognized.

3. Geological Sketch of the Gower Peninsula.

The peninsula of Gower forms a broad headland, which projects into the Bristol Channel, bounded on the E. by Swansea Bay, and on the W. by the Bay of Carmarthen. The fundamental rock is a thick mass of old red sandstone conglomerate, which forms the axis and highland of the promontory, rising into the hills of Llanmadoc and Cefn-Bryn. This conglomerate is flanked N. and S. by strata of carboniferous limestone, and the base of the peninsula, where it joins on to the mainland of Glamorganshire, forms a part of the coal measures of South Wales. The line of southern coast stretches from the 'Mumbles' on the E. to the 'Worm's Head' on the W., and with the exception of the indentations, of Port Eynon, Oxwich, and other smaller bays, it presents an iron-bound wall of bold, lofty, and precipitous or scarped cliffs, occasionally exhibiting features of the grandest description. The general character of the coast section is well seen at 'Shire Coom' (Sheer Cwm), near the 'Three Cliffs Bay.' In addition to the well-known raised beach at the 'Mumbles,' Mr. Prestwich detected in Mewslade Bay, at the western end of the section, another example of the same kind boldly defined, and forming a continuous stretch of fully a mile in length. In 'Rhos Sili Bay,' and on the summit of Cefn-Bryn, he ascertained the presence of residuary patches of boulder clay. Mr. Prestwich has favoured me with a memorandum of his observations, which is annexed as an appendix (p. 536).

4. List of Names and Position of the Bone Caves.

With the exception of 'Spritsail-Tor,' on the west side of the peninsula, all the known ossiferous caverns of Gower occur along the southern coast line between the Mumbles and the Worm's Head; they are confined to the carboniferous limestone, and within a limited range of variation they are at different heights above the sea: the floor of 'Bacon Hole' being 30 feet above the highest tides, while the lower story

of 'Bosco's Den' is breached by the waves and washed out to a depth inwards of 31 feet. The two most eastern, namely the Mumbles and Caswell Bay caverns, have been entirely destroyed by the action of the sea, and a very few only of the organic remains found in them have been preserved. These are now deposited in the Swansea Museum. The next in succession westwards are the group of contiguous caverns which occupy the but slightly indented line of coast, stretching between 'Pwll dhu' Head and 'Sheer Cwm' in Three Cliffs Bay. The best known of these are 'Bacon Hole' and 'Minchin Hole,' which have been especial objects of exploration by Colonel Wood since 1850, and have yielded a large quantity of mammalian remains of the highest interest and importance. 'Bacon Hole' and 'Minchin Hole' are several hundred yards apart, but between them there occur a series of detached caverns, which like Minchin Hole are not entered on the Ordnance Survey Map of Gower. They have only become known through the persevering exploration of Colonel Wood. The principal of these are the very remarkable and instructive two-storied cavern recognized by the quarrymen in the neighbourhood, under the name of the 'Devil's Hole;' then 'Bosco's Den' and 'Crow Hole,' and lastly on the western side of 'Minchin Hole' towards Three Cliffs Bay, a cavernous fissure impacted with sand, which Colonel Wood has named 'Raven's Cliff.' One cavern, near Langland Bay, called 'Ram-Tor,' and presumed to be ossiferous, still remains unexplored.

Dr. Buckland gives a brief account in the 'Reliquiæ Diluvianæ' of a deposit of fossil bones discovered in 1792, in a cavity in the limestone of the 'Crawley Rocks'[1] in Oxwich Bay, which is no longer in existence. With this exception, no bone-caves have as yet been disclosed in Oxwich Bay or Port Eynon Bay. From the western point of the latter to the Worm's Head, the general alignment of the coast is comparatively straight, with a slight deflexion to the N., and with few indentations. The limestone cliffs are here lofty, exceedingly steep and precipitous, and about the middle of the stretch, on the face of the 'Yellow Top' rock occur the two contiguous cavernous fissures, commonly known as the 'Paviland Caves,' discovered in 1821, and so celebrated through the researches of Dr. Buckland. On the western side of the Gower coast the limestone strata have been denuded in Rhos Sili Bay; but to the north of Llanmadoc Hill, where they reappear in a narrow belt, a cave buried in drift sand was casually disclosed, through quarrying operations in 1839, on the point called 'Spritsail-Tor.' It was

[1] See *antea*, p. 354—[Ed.]

partially examined by Sir H. de la Beche, and thoroughly explored by Colonel Wood in 1849. Although but of contracted dimensions, it has yielded a very large quantity of fossil bones, belonging to many genera and species.

5. 'Mewslade Bay.'—Raised Beach observed by Prestwich.

Before proceeding to notice the contents of these caves, it will be convenient to refer to the highly valuable observation made by Mr. Prestwich upon the raised beach of Mewslade Bay, when he and I visited Gower last autumn. A thin layer of marine sand, containing shells of common existing species, was observed by Mr. Starling Benson and Colonel Wood, at the bottom of the deposits in 'Bacon Hole' cavern; and marine deposits of sand and gravel are common on the floors of some of the other Gower caves, as will be shown in the sequel. It was of importance to place these beds, either in correlation with, or distinction from, some definite patch of raised beach in the neighbourhood. Mr. Prestwich discovered in Mewslade Bay, between Paviland and the Worm's Head, the well-marked illustration of this nature, represented by the accompanying section, for which I am indebted to his kindness (p. 537). At ten or twelve feet above the level of high tides there is perched upon the weathered outcropping edges of the limestone a narrow belt of raised beach, a mile in extent. The section shows a bed 3 feet thick, composed of fragments and pebbles of limestone, with entire and broken shells, imperfectly cemented by a calcareous paste. Above this there is a bed of reddish sand, 4 feet thick; and the whole is overlaid by an enormous mass, varying from 20 to 30 feet in thickness, of angular fragments of carboniferous limestone, being the debris of the immediately adjoining rocks. This bed is developed in vast accumulations, at a considerably higher level, on the face of the cliffs between 'Bacon Hole' and 'Minchin Hole,' and it constitutes a well-marked example of 'Brèche en place,' or the bed which Mr. Godwin-Austen has characterized, in his memoir on the 'Pleistocene Period,' under the designation of 'Head.'[1] Mr. Prestwich's remarks on the traces of 'Boulder Clay' in Gower will be found in his notes in the appendix.

6. 'Bacon Hole' Cavern.

Description.—The cavern of 'Bacon Hole' may, with advantage, be taken first, as it was very carefully explored, under the constant superintendence of Colonel Wood; and an

[1] Quarterly Journal Geol. Soc, vol. vii. (1851), p. 121.

excellent account of the operations, with plans and sections, has been published by Mr. Starling Benson,[1] founded on observations made during the progress of the work, which relieves me from the necessity of a minute description on the present occasion. 'Bacon Hole' is situated about the lower third of the limestone cliffs on the sea coast, about six miles west of Swansea, and in a line nearly due S. from Kilvrough. You descend from a level grassy plateau by a steep and difficult path along the cliff, till you come upon the brink of an enormous accumulation of cemented angular breccia, below which, but a little more to the E., opens the cavern towards the sea, and directed to the SE. The mouth is wide and open, with diverging walls admitting the free access of light to the interior. The cavern is evidently, as has been observed by Mr. Starling Benson, in the line of one of numerous faults which intersect the limestone of South Wales. A cleft continuous with that of the cave can be seen stretching out into the sea, and bending slightly to the east, upon the rocky platform below which forms the present sea beach. The walls of the interior lean to and meet so as to form an anticlinal axis along the centre of the roof, in part of which the remains of a wide chasm are visible, which was probably continued upwards in a flue. This chasm is at present in a great measure blocked up with masses of breccia, sheeted over by an abundant coating of stalagmite; but, like the corresponding flue in the roof of Paviland, as figured in Buckland's section, it may have formed a channel through which *injecta* were precipitated from above into the cavern. The upper parts of the interior are mostly covered over with a cake of stalagmite. There is a copious drip from above, which keeps the surface soil of the floor in a soppy state. The roof slopes from the outside inwards, and it is most probable that the cavernous fissure is continued much further back than is now apparent, but blocked up by breccia and stalagmite. The extreme height of the interior is about 20 feet.

(*a*.) *Section of the Floor Deposits*.—The floor of the cavern at the entrance consists of a thick accumulation of cemented angular limestone breccia, which is well seen in section from the outside below. This breccia can be traced seaward upon the diverging walls beyond the existing portion of the cave, for a distance of 100 feet.[2] The floor slopes down from the entrance inwards. The uppermost layer of stalagmite is, according to Mr. Starling Benson, 30 feet above the level of

[1] Account of the Cave Deposit of 'Bacon Hole' 'Annual Report for 1852 of the Swansea Literary and Scientific Society,' p. 9.

[2] Starling Benson. *Op. cit.* p. 13.

high water. Great difficulty was encountered in conducting the excavations, from the cemented breccia of the floor being too hard for the pickaxe, and too cavernous to blast. The following section, taken near the middle, is given by Mr. Benson as showing the average thickness and succession of the various deposits:—

1. At the bottom, and lying immediately above the rocky floor, patches of yellow sand, a few inches thick, abounding with shells of *Litorina rudis* and *Litorina litoralis*, in groups and in every stage of growth, implying as Mr. Benson remarks, 'that when these sea mollusca lived, the floor must have been below the level of high water.' Besides these marine forms, a smaller number of shells of *Clausilia nigricans* were found in the same sand, together with bones of birds and of a species of *Arvicola*. The *Clausiliæ* were enveloped by—

2. A thin layer of stalagmite, which could not have been formed until the floor of the cavern had been elevated above the level of high water.

3. Upon this stalagmite, a bed of blackish or dark-coloured sand varying in thickness, as I have been informed by Colonel Wood, from 18 inches to 2 feet, and containing a mass of bones consisting almost entirely of various parts of the skeleton of an Elephant, which I have ascertained to be *Elephas antiquus*, including numerous molars. These bones when first exposed were quite soft and friable, crumbling under the fingers when handled; but after a few days' exposure to dry air they became hard and susceptible of repair. The tooth of a Badger (*Meles Taxus*) and of a *Putorius* were found at the lower part of the same sand.

4. Immediately above the black sand, and at places almost intermixing with it, a deposit of 'red soil' or ochreous cave loam, containing remains of the same species of Elephant, and several lower jaws, with detached upper molars, vertebræ, and bones of the extremities of a species of Rhinoceros, which I have named *Rhinoceros hemitœchus*, distinct alike from the *Rhin. tichorhinus* of the superficial gravels, and from *Rhin. leptorhinus* of the Sub-Apennine Pliocene deposits. Along with these were found bones of *Hyæna*, *Wolf*, *Ursus*, *Bos*, and *Cervus*. This stratum varied from 1 to 2 feet in thickness, from the intermixture, in some places of loose limestone breccia, and in others of sand free from bones. The breccia is represented in Mr. Benson's section as a separate bed. The blackish sand and cave-earth beds may be regarded as different conditions of the same deposit. Mr. Benson remarks that this latter was the only deposit found in the cave similar to the soil (ochreous loam) usually met with in bone-

caverns resorted to by Carnivora. No coprolites of Hyæna were observed in any of the floor deposits.

5. Above the stratum of red-earth and breccia a bed of stalagmite of very irregular thickness, under which, and partly embedded in it, was found the portion of an Elephant's tusk, which measured 5½ feet in length with a girth of 24 inches. This tusk lay about 4 feet above the bones of Elephant in the lower deposit.

6. Above this bed of stalagmite, another bed of breccia, in most places cemented throughout by stalagmite, and containing entangled bones, chiefly of *Ursus* and *Bos*, and mostly entire; but which could rarely be extracted unbroken. It varied from 1 to 2 feet in thickness.

7. The uppermost bed of stalagmite, forming a very regular deposit, which ranged generally from 9 inches to 1 foot in thickness, but in some places extended to upwards of 2 feet. Colonel Wood informs me that some remains of *Ursus* were found occurring in the stalagmite.

8. A superficial deposit of dark-coloured alluvial earth, about a foot thick, containing the bones of *Bos*, *Cervus*, *Canis Vulpes*, together with horns of Red Deer and Roebuck, the latter in one instance bearing distinct marks of having been wrought by human hands. Recent shells were also found in this stratum, consisting chiefly of *Patella vulgata*, *Mytilus edulis*, *Purpura lapillus*, and *Litorina litorea*. These appear to have been brought into the cavern by birds as food.

'No remains of man were found *below* the upper stalagmite. In the mud *above* it were pieces of ancient British Pottery.'[1] (Starling Benson.)

(*b*.) *Organic Remains*.—It is not my intention now to enter on a detailed identification of the different species of mammalia found in 'Bacon Hole,' nor to analyze the conditions under which they were associated. I shall confine myself to such as appear to be most significant, as positive indicators of the age of the deposits. Sir Charles Lyell, so recently as in the supplement to the last edition of the 'Manual,' states that 'to what part of the Pliocene period the cave animals of Great Britain should be chiefly referred is still a vexed question.' The large Pachydermata, belonging to the genera *Elephas*, *Rhinoceros*, and *Hippopotamus*, are of the most weight in their indications, and it is of the last importance to discriminate with precision the species to which the remains occurring in the caves belong. The vagueness which

[1] The above summary of the cave deposits is mainly a condensed abstract of Mr. S. Benson's excellent description.

has heretofore attached to the term 'Mammoth,' when Elephants have been cited, is now generally admitted; and I believe that a corresponding looseness has applied to the species of *Rhinoceros*.

Colonel Wood, at whose charge the excavations were made, presented the collection of fossil bones to the Museum of the Royal Institution of South Wales at Swansea, where they are now carefully preserved, and I have had several opportunities of examining them in detail.

Elephant Remains.—These consist of 11 molars or fragments of molars of the upper and lower jaws of young and adult animals; a fragment of an enormous tusk 24 inches in girth, and 5½ feet long when measured in the deposit; 6 vertebræ, chiefly dorsal and lumbar, but of different sizes, indicating more than one individual; 2 humeri, right and left, apparently of the same animal, comprising the inferior two-thirds of the shaft: the head of one of them present, but detached; 1 radius and ulna quite entire; 1 huge femur, corresponding in size with the humeri, and probably of the same individual, the shaft and condyles entire, the articular head present, but detached; 2 tibias of large size and entire, corresponding with the femur and humeri; 2 tibias, also entire, but of a smaller animal; 1 calcaneum of the right side, of large size, and in fine preservation; 14 metacarpal and metatarsal bones.

The molars present all the characteristic marks which distinguish *Elephas antiquus* from the true Mammoth, *E. primigenius*; namely, comparatively narrow crowns, with fewer ridges, the plates of enamel thick and well crimped, and the discs of wear wide and open, with a tendency to expansion in the middle. They agree in the closest manner with molars of the same species, *E. antiquus*, from the Oyster-bed of the Norfolk coast, Saffron Walden, Clacton, Grays Thurrock, the mud-bed of Pagham, and the Sub-Apennine deposits of the Astesan. One of them consists of a last true molar of the lower jaw, right side, presenting fourteen principal ridges, to a length of 11 inches. Another is the corresponding tooth of the left side; another is a third milk molar of the upper jaw, right side—not quite entire, but very characteristic; another is a germ specimen of an upper antepenultimate true molar. The remaining specimens are more or less fragmentary, but are alike characteristic of *E. antiquus*. Not a vestige indicative of *E. primigenius* was detected, either among the teeth or bones. The remains belonged to at least three individuals, one of large size, another smaller, and a third which had not quite passed through the last stage of milk dentition. The bones were free from marks of gnawing,

and they bore no appearance of having been rolled or transported from a distance.

Rhinoceros Remains.—These were found in abundance in 'Bacon Hole,' and in still greater quantity in 'Minchin Hole,' situated a little further to the westward. Every tooth and bone which admitted of identification was found to belong to *R. hemitœchus*, so named from the presence of a partial bony septum between the nostrils, but differing in a very pronounced manner from *R. tichorhinus*, by the configuration of the cranium, by the form and characters of the upper molar teeth, by the absence of an edentulous beak-shaped prolongation of the symphysis of the lower jaw, in advance of the anterior molars, and in the form and proportions of the bones, generally throughout the skeleton. It differs equally from the original type of the *R. leptorhinus* of Cuvier, founded upon Cortesi's cranium found near Piacenza, which had no bony septum; and from *R. Etruscus* of the 'Sabbione' and 'Sansino' deposits of the Val d'Arno, which species, however, had likewise a bony nasal septum, but is distinguished at once from *R. tichorhinus* and *R. hemitachus* by its smaller size, light form, and comparatively slight limbs, besides special characters in the shape of the skull and teeth. The *R. hemitœchus* of the Gower caves is identical with the Clacton form, the skull of which has been described by Professor Owen in the 'British Fossil Mammalia,' under the specific designation of *R. leptorhinus* of Cuvier; but I have been led to the conclusion that it is wholly distinct from the true type of the latter species.

The following remains, referable to *R. hemitœchus*, were found in 'Bacon Hole':—Three adult rami of the lower jaw, comprising the entire series of molar teeth in fine preservation; two of the rami belonging to one individual. Six detached molars of the upper jaw, three of which are of the right side and consecutive teeth, probably of the same individual. Of the others, two are of the left side, and one of them at least indicates an individual of a different age. A fragment comprising the lower half of the shaft of the right humerus, the outer condyle wanting. A radius presenting the superior half of the bone, with the articular surface. The corresponding ulna, mutilated, of the olecranon. Two metacarpal or metatarsal bones. Two cervical vertebræ, in fine preservation. One lumbar vertebra. A right half of the pelvis.

The marine sand at the bottom of 'Bacon Hole' was analogous to the thin bed on the rocky floor of the Grotta di San Ciro, near Palermo, but contained fewer species of Mollusca. Here the resemblance ceases. In San Ciro, an enormous thickness of breccia, also of marine origin, and crammed with

bones, is accumulated above the sand; while in 'Bacon Hole' the alternate deposits of stalagmite, black sand, ochreous earth and breccia, up to the top, were all of sub-aerial formation.

7. 'Minchin Hole' Cavern.

Description.—The bone cavern named 'Minchin,' or 'Minchin Hole,' became the next object of Colonel Wood's explorations. It is a very spacious cave, of a grand and lofty character, several hundred yards to the west of 'Bacon Hole,' and separated from it by a bight or indentation of the coast, the lower terrace of the intervening cliff being surmounted by an enormous accumulation of cemented limestone-breccia. It is situated in the bottom of a dark and gloomy recess, and like 'Bacon Hole,' the excavation follows the line of a fault in the limestone strata. The mouth is open and so lofty that light penetrates a considerable way into the interior. The following are the principal dimensions:—

Length from the outer arch to the extremity of the cave, 170 ft. Height at the entrance, about 35 ft. Width at ditto, below the arch, 17 ft. Greatest width of the interior, 70 ft. Ditto, ditto, at 6 ft. from the end, 36 ft.

(*a.*) *Section of the Floor Deposits.*—The cavern is entered by ascending a steep step of talus, composed chiefly of ejected materials; this is succeeded by a more level space, about 35 feet in length, which in turn is succeeded by a second step of talus, stretching 51 feet back to the end of the cave. The floor is very unequal, and the excavations were but partial, having been greatly impeded by enormous accumulations of stalagmite covering the inferior deposits. They were carried on more with a view to the exhumation of more perfect remains than were found in 'Bacon Hole,' and less attention was in consequence paid to the varying thickness and other minute details of the different deposits. At the entrance the floor was covered with (1) loose debris and breccia of limestone to the depth of 3 feet, succeeded by (2) a stratum of cave-earth about 9 inches thick; (3) one foot of sand; (4) next, a deposit of blackish or dark-coloured loamy sand, resembling in mineral character the corresponding ossiferous deposit of 'Bacon Hole,' and attaining a depth of 2½ feet:—abundant remains of *Rhinoceros*, *Elephas*, and *Bos* were yielded by this bed, and shells of *Helix hispida* were found attached to the matrix which encrusted some of the bones; (5) at the bottom, and resting upon the rock-floor, lay a bed of greyish-yellow, coarse, and gritty marine sand, ranging from one foot to four feet in thickness, which yielded a considerable quantity of bones of

R. hemitœchus. One of the lower jaw-fragments of this species, from this deposit, exhibits a rolled *Litorina* and specks of comminuted shells embedded in the encrusting gritty matrix. Shells of *Clausilia nigricans* with *Litorinæ* were yielded by other specimens.

Working inwards the sand disappears, and the section yielded: (1) above, a bed of loose strong breccia of varying thickness; (2) cave earth, 18 inches; and (3) black unctuous sandy loam, 1 foot. Nothing was met with corresponding to the repeated alternation of the beds of stalagmite with the other deposits, seen in 'Bacon Hole.' The stalagmite was accumulated in local masses and not spread out in horizontal sheets. A large and very important series of Mammalian remains was exhumed from the interior of the cavern, chiefly from the shelving floor close to the western wall, near the middle and back part of the cavern. They occurred alike in the marine sand at the bottom and in the black sandy loam overlying it. As a general rule, they were closely analogous to those met with in 'Bacon Hole.' It is not my intention, on the present occasion, to go into details on the genera and species. As regards the Pachydermata, Elephant remains were fewer, and Rhinoceros remains much more numerous and important as specimens, than in 'Bacon Hole.'

(*b.*) *Organic Remains.*—Among the Elephant bones was a specimen comprising the anterior two-thirds of the left ramus of the lower jaw of a very young calf showing the empty alveoli of the three milk molars. This specimen shows superficial marks of gnawing. Among the molars were two very perfect and characteristic specimens, both of *Elephas antiquus*, the one being an upper true molar, presenting 15 ridges to a length of crown of about $8\frac{1}{2}$ inches, and the other a lower molar of the right side, showing 16 ridges on a crown 10 inches long. These two teeth probably belonged to the same individual. The discs of wear presented the peculiar characters of *Elephas antiquus* in a very perfect manner; namely, the discs of considerable width and the enamel plates comparatively thick, with well pronounced undulations. As in 'Bacon Hole,' not a specimen of Elephant was here observed referable to *Elephas primigenius.*

The remains of Rhinoceros in Minchin Hole were numerous, and proved the presence of several individuals, of all ages. Among these were two adult crania, of which one was exhumed in a very perfect state of integrity, from the occipital condyles to the incisive border. It had belonged to an old animal; the series of molars was present on either side, and I am assured by Colonel Wood, in the most positive

manner, that there was a very distinct and well-marked bony septum, connecting the nasal bones with the incisives. This important specimen unluckily met with a grievous accident in a public museum, by which the skull was crushed and the fragments lost; but the palate, with the maxillaries and molars of either side, remain to prove that it belonged to *Rhin. hemitœchus*. The other cranium was discovered entire, but fractured in extricating it from the deposit. The posterior half, represented by the accompanying figures (see Plates XXIII. and XXIV.) was preserved, and it agreed very closely in form with the Clacton cranium, figured in the 'British Fossil Mammalia,' and with another of the same species, from Northamptonshire, now in the Palæontological collection of the British Museum.[1] Among the other specimens of Rhinoceros were: 4 fragments of upper jaws containing teeth; 2 upper maxillaries of very young animals, containing the milk teeth; 8 lower jaws, of which three are of very young individuals, with milk teeth only; 1 atlas vertebra nearly entire; several dorsal and lumbar vertebræ; 1 scapula; 1 humerus, showing the inferior half of the shaft and the condyles; 1 radius nearly entire; 4 femora, two of which are of very young or fœtal animals; 2 astragali, one of them superficially gnawed; 1 tibia and fibula in fine preservation; 1 calcaneum; 5 ossa innominata, some of them showing the cup of the acetabulum perfect. The above list is intended to show the abundance in which the remains of *Rhinoceros hemitœchus* occur in 'Minchin Hole.' The diagnostic characters of this species, as compared with *R. tichorhinus* and *R. leptorhinus*, throughout their respective skeletons, have not yet been published. It would be out of place to enter on such details here, in a communication which professes to be merely a summary of observations made on a series of caverns. But it is especially deserving of remark, that although molars and other bones of *R. tichorhinus* have been found in very considerable numbers in some of the other Gower caves, such as 'Spritsail-Tor,' 'Paviland,' and 'Caswell,' not a tooth or other remain referable to that species was identified, either from 'Bacon Hole' or 'Minchin Hole.' The same negative observation, as I have already stated, applies to *Elephas primigenius*. Bones of *Bison priscus* were common; but remains of *Cervidæ* very rare.

Of the Carnivora, the nearly entire skull of a Hyæna, *Hyæna spelæa*, with fragments of lower jaws and various bones of the skeleton, was met with; also remains of *Canis Lupus* and of *Ursus spelæus*, but none referable to *Felis spelæa*.

[1] See *antea*, p. 351.- [Ed.]

No coprolites of Hyæna were encountered, nor bone splinters bearing teeth marks, nor detached molars of *Equus*. 'Minchin Hole,' from these negative results, does not appear to have been much frequented as a Hyæna's den, although some of the bones bear distinct marks of gnawing; these are very pronounced upon the astragalus and condyles of the femur of a Rhinoceros; while the lower jaw of a fœtal Elephant presents superficial grooving, as if gnawed by a Wolf rather than by a Hyæna.

The remarkable state of integrity in which the two large skulls of *Rhinoceros hemitœchus* were discovered is not a little significant. They bore no marks of having been dragged in by any predaceous animal; and it is hardly conceivable that they would have been precipitated from a fissure above, without being fractured into many pieces, considering the great height of the roof. It is equally improbable that the animals were at any time alive in the cavern, for from the difficult nature of the approach it could never have been accessible to large Pachyderms like *Rhinoceros* and *Elephas*. The two crania were embedded in marine sand, at the bottom of the deposits; and under all the circumstances, it seems most probable that they were drifted in by the waves, although it is difficult even then to understand how they could have escaped without injury or marks of rolling.

8. 'Bosco's Den' Cavern, upper story.

I now pass to the consideration of another series of caverns, or cavernous fissures, of very high interest, arising not so much from the abundance and importance of the organic remains contained in them, as from the nature and succession of their marine and alluvial deposits, and from the flood of light which they throw upon the emergence of the caverns above the sea, the manner of their filling up by transported materials, and the proofs of subsidence within a comparatively modern period, which they unfold. The merit of the discovery of this series belongs wholly and solely to Colonel Wood. Some of the localities, indeed, were known to the quarrymen who resort to the cliffs, by vague and uncertain names; others bore no designation whatever, and the names which will be cited in the sequel are, with a single exception, those which have been either applied to them or adopted by Colonel Wood. I must premise further, that the value of any reasoning upon alleged proofs of subsidence must necessarily depend much upon the reliability of exact hypsometrical data, as to the relation of the level of the sinking or sunk deposits to the mean level of the adjoining sea. Obser-

vations of this description are of great delicacy—they demand considerable time and repeated local inspection. In short, they are not of the nature that lie conveniently to the hand of a non-resident palæontologist; and in the remarks which follow, when the elevation of the deposits is in question, the figures will refer to the height above the platform, at the foot of the cliffs, which is dry between high and low water; in other words, to the subjacent beach in the ordinary sense of the term.

(*a.*) *Description.*—Two years ago, a small black opening, looking in the distance not much bigger than a fox-hole, was visible from the rocky platform below, in the cliff, about midway between 'Bacon Hole' and 'Minchin Hole.' It was quite inaccessible by ordinary climbing, and was known to the quarry-men by the name of 'Bacon's Eye.' The lower terrace of the cliff, which here faces the sea, rises perpendicularly about 90 feet above the rugged reef which forms the beach. The limestone strata of the cliff are intersected by vertical chines, which widen and contract irregularly at intervals, from the step of table-land above to the base, and are continued outwards as clefts on the denuded platform that stretches under the sea. The angular aperture, called 'Bacon's Eye,' was situated about 72 feet high, in one of the largest of these fissures, and it did not exceed 2½ feet in diameter. Below it, and wedged in between the walls of the fissure, there was seen a great bulging vertical mass of angular fragments of limestone impacted in ochreous loam, and resting on the projecting ledge of a thick and solid mass of cemented blocks and breccia, which subsequently proved to be the dividing floor of a two-storied cavern. In the ochreous mass, white fragments of bone could be distinguished by their bleached colour from below, at a distance of 56 feet, jammed by, and irregularly intermingled with, the fragments of the breccia. On clambering up to the base of the ochreous mass, by a devious ascent apart from the main fissure, we found our further progress towards the 'Eye' aperture intercepted by a perpendicular fall of about 20 feet. The remains, seen from below, proved to be fractured bones and teeth of *Bos*, bones and antlers of Deer, and teeth and phalangeal bones of Wolf, confusedly disposed in every direction, together with land-shells cemented by calcareous infiltration. Stimulated by these appearances, Colonel Wood determined to follow up the indications; the contracted aperture above was at length reached by ladders and widened, when it was found to lead into a fine cavern full of objects of interest. In order to make it accessible, and carry on the operations within, it became necessary to remove the external accumulation of loam and

breccia in front of and below the mouth. The projecting ledge upon which it rested was undermined, and the whole was precipitated in mass into the abyss, where it soon disappeared under the action of the waves at high water. The mass measured about 16 feet in height; the width was 4½ feet at the top, 8 feet in the middle, and 7 feet at the base, where the depth from the fissure, forwards, amounted to 8 feet. The rock on one side extended beyond the opposite wall of the fissure a distance of about 50 feet seaward. A streak of the loamy breccia, continuous with the mass *in situ*, was traceable along the projecting side for a distance of about 30 feet, indicating that the progressive encroachments of the sea must have undermined part of the cliff, and swept off large masses of the superincumbent breccia.

To avoid the risk of confusion between 'Bacon Hole' Cavern and 'Bacon's Eye,' I suggested for the new cavern the name of 'Bosco's Den,' by which it is designated throughout in the present communication. The mouth opens upon the sea, towards the SSE., and the cavity extends backwards a distance of 76 feet, with a slight alteration of direction near the middle; the outer division measuring along the western wall 30 feet, and the inner, which is deflected a little to the E., 46 feet. At the entrance, the width of the fissure near the middle is 7½ feet; it soon expands to 11 feet, and retains this size with considerable uniformity throughout, the greatest width being about 16 feet, and the minimum, where contracted near the end, being 9 feet. The same remark applies to the height, which is mostly about 14 or 15 feet. The walls of the fissure are also very regular; there are no lateral offsets, nor cul-de-sac expansions. The western wall throughout is much more vertical than the eastern, which leans to it, and near the shaft or flue in front of the angle of the bend it is nearly perpendicular. The walls meet at the apex so as to form a kind of Gothic roof, of which a narrow line of fissure forms the ridge-pole. The gable end near the extremity has the slopes inclined at a high pitch. The eastern wall, a little behind the middle, shelves out so as to form a nearly horizontal or but slightly inclined ledge, which is interrupted near the great flue, and then re-appears on the western side, in the anterior division of the cavern. The eastern or more inclined wall is sheeted over by a thin coat of stalagmite, of which but little or none is seen upon the western wall. The fissure of the roof, a little in front of the angle of bend, is continued upwards in an irregular shaft or flue, which evidently communicated with the surface. It was choked up with detritus of the same nature as the upper deposits of the floor, the surface aperture being covered over with a coating

of turf. The height of the cavern immediately under this shaft is 40 feet. The inward termination is rounded, but abrupt, the end being composed of a great mass of undisturbed stalagmite, which blocks up the continuation of the fissure. At 9 feet from the end the roof still maintains an elevation of 16 feet.

(*b.*) *Section of Floor Deposits.*—The mouth of the cavern is now laid open to a depth of 22 feet, Colonel Wood having excavated down to the fundamental stratum of blocks and breccia through 19½ feet of deposits, below the 'Eye' aperture of 2½ feet. When originally opened, the floor was tolerably smooth, and shelved down gradually from the mouth to the extremity, causing the section to exhibit a greater depth of deposits outwards, and gradually decreasing inwards. Colonel Wood, who daily superintended the progress of the operations, drew up an account, at my request, which I have incorporated with my own observations. The following deposits were observed:—

1. On the surface a bed of sandy peat, stretching all the way back from the bend to the extremity through 46 feet, and varying in thickness from 12 to 15 inches. The peaty substance consisted of bits of sticks and decomposed and comminuted vegetable matter, freely mixed with coarse reddish sand, but maintaining a fair amount of cohesion. In front of the bend, this bed gradually thinned off as it rose on the slope towards the mouth, where it disappeared entirely. The greatest accumulation was immediately under the shaft in the roof, where it formed a flat conical pile like a grain-heap. The materials were here loosely aggregated, and filled several barrow loads when wheeled out by the workmen. It is deserving of notice that, notwithstanding the fissure character of the cavern roof, this stratum of peat was free from obvious moisture. This is explained by the unusual circumstance, that the interior in its existing condition is perfectly dry and free from drip, notwithstanding the great amount of stalagmitic deposition at the next lower level. In this peaty stratum there were found, either embedded or lying on the surface, bones of *Bos* and Wolf, and bones and fragments of the antlers of Deer. Upwards of thirty well-marked specimens, comprising the basal portions, with the bur, and more or less of the beams of antlers belonging to the species or variety allied to the Reindeer, and known under the name of *Cervus Guettardi* or *priscus*, were exhumed from the peat, together with the cerebral part of one cranium of the same form. It is deserving of notice that they were all shed horns, no portion of the frontals having in any case been found attached to them. The same remark, as a general rule, but with a

percentage of exceptions, applied to the enormous quantity of antlers of the same species, which were met with in the lower deposits. The bones and antlers occurring in the peat, as might have been expected, were fresher, and in a better state of preservation than those found in the loam below. The source of this peaty stratum is evidently traceable to the shaft in the roof, with which all the observed conditions were in direct and obvious relation.

2. Immediately underlying the peat there occurred a very regular and uniform bed of stalagmite ranging in thickness generally from 6 to 9 inches, but in some places attaining 1 foot. It formed a slightly undulated sheet, extending from the mouth to the bottom of the cave. This was the only layer of stalagmite encountered in the section. I observed one phenomenon of great significance in relation to this deposit. Close to the eastern wall, near the angle of the bend, the stalagmite attains a thickness of 12 inches, and suddenly rises into an obtusely conical boss, measuring 2 feet 3 inches in height by 2 feet 6 inches of length at the base, and with a width of 1 foot 6 inches. It is free from adhesion to the wall of rock. This boss is rent through vertically, and shivered in every direction, with partial dislocation of the fragments. But the remarkable circumstance is, that the *pieces are loose and uncemented*, proving that notwithstanding the great amount of drip which must have at one time existed to form the stalagmitic floor, not a single drop of water charged with lime in solution has fallen upon it, since the shock which reft the boss into its present shattered condition. About eight feet further in front there is another boss close to the eastern wall, which is also shivered, but not rent to the same degree. Constant Prévost and Desnoyers, when arguing against the sole agency of Hyænas and other Carnivora, in explanation of the common occurrence of bones in caves, have earnestly insisted upon the great amount of change which must have taken place, after upheaval and subsidence, in the course of subterranean rills. The uncemented condition of the shivered ball in 'Bosco's Den' is a striking illustration of the truth of what they inculcated.

3. Below the stalagmite was a bed of ferruginous sandy loam, containing dispersed angular fragments of rock, measuring about 1 foot 4 inches in thickness. Colonel Wood informs me that very few, if any, bone-remains were found in this stratum.

4. Next, a deposit of sand about 2 feet 6 inches in depth, without bones.

5. Below the sand, a bed of loose angular breccia. Few or no bone-remains were met with in this bed, which measured 4 feet.

6. Next, a bed of cave earth, or yellow ochreous loam 6 to 7 feet thick, containing sparsely disseminated angular fragments of limestone, and occasionally a large block. This extended down to the cemented fundamental stratum of blocks and breccia, forming the diaphragm between the upper and lower stories, and upon the ledge of which the ochreous bone-breccia rested that was precipitated into the chasm below.

The above may be taken as fairly representing an average section of the deposits. But they varied a good deal in relative thickness, according to the distance from the mouth where the section was taken. Near the entrance, and for a stretch of 26 feet inwards, what remains of the deposit upon the walls exhibits nearly throughout, from the stalagmite bed down to the bottom, a rich yellow ochreous loam or cave earth, interspersed with small fragments of limestone. Inwards from the bend, towards the extremity, the loam is intermixed with a gritty incoherent sand; but the excavations have not been carried out so deeply here. Near the end, the section, when I last visited 'Bosco's Den,' extended only to a depth of $2\frac{1}{2}$ feet below the stalagmite floor, the workmen having been afraid of the substratum giving way, and precipitating them into an unknown chasm below.

(c.) *Organic Remains — Singular abundance of shed Deers' Antlers.*—Taking into account the close proximity of 'Bosco's Den' to 'Bacon Hole' on the one side, and 'Minchin Hole' on the other, and the very considerable aggregate formed by its deposits, the association of animals found in it is not a little remarkable. Not a single specimen referable to any species, either of Elephant or Rhinoceros, was ever met with in 'Bosco's Den' by Colonel Wood. Teeth and bones of *Hyæna spelæa* and of the Cave Lion were equally wanting; so also were teeth of *Equus*, which are excessively abundant in Paviland and 'Spritsail-Tor.' Bones of Bear were frequent; those of Wolf very abundant, together with bones of Fox, Deer, and *Bos*. But the most singular circumstance was the extraordinary abundance of the antlers of Deer. I passed through my hands, in the collection at Stout Hall, no fewer than 750 distinct antlers, belonging either to varieties of Reindeer or to a species (*Cervus Guettardi*) very closely allied to it. I afterwards saw in the cave about 50 more, and Colonel Wood has by subsequent acquisitions raised the number to somewhat short of eleven hundred. To guard against error, no specimens were taken into the reckoning but such as presented the base of the beam and bur. As a general rule, they were of small size, more or less broken, and the great majority of them belonged to young animals.

Another fact was observed, which is worthy of notice, when speculating as to the agency by which they were introduced into the cavern, viz., that about 95 per cent. of these antlers were shed horns, and some of them were very much rolled. I believe that the above reckoning falls very much short of the actual number of antlers that were present in the fissure; and that a large number of them were probably contained in the mass of ochreous loam, 15 feet high by 8 feet square at the base, which was precipitated bodily into the sea.

9. 'Bosco's Den,' Lower Story.

(*d.*) *Description of lower chamber.*—We were well aware of the existence of some kind of cavity under the projecting ledge of cemented breccia upon which the 'cave-loam' rested, but it was quite inaccessible from above; and no attempt was made to penetrate it, until the excavations in the upper story were nearly completed. At length Colonel Wood, Mr. Thomas Falconer of Usk, and myself, having brought the necessary appliances to the spot on September 14 last, accomplished our first entry into the interior. By ladders we ascended between the vertical walls of the empty fissure to a contracted platform, which led back into a washed out chamber, extending 31 feet inwards from the mouth, and immediately under the floor of the upper chamber. The width of the chasm at the mouth was 8 feet 9 inches, which increased inwards to 10 feet, and the height of the chamber to the projecting ledge of cemented breccia which forms the roof was 12 feet; chinks intervened between the jammed blocks of limestone, forming the floor; and by dropping a line, its elevation of floor was found to be 21 feet above the edge of the beach. The height of the chamber diminished inwards, by the inclination of the roof; at the extremity, it was reduced to 9½ feet. Here we got a section of the compact bed of marine sand and gravel, which forms the end wall, breached by the sea at high tides, and during heavy south-westerly gales. In the descending order, it is composed of:—

(*e.*) *Deposits of Marine Sand and Gravel*—

		Ft	In.
1.	A layer of coarse rolled gravel	2	0
1*a*.	A thin layer of pebbles . .	0	4
2.	Fine comminuted gravel .	2	8
3.	Sand mixed with fine gravel .	2	4
4.	Coarse rolled gravel . .	2	0
		9	4

No shells or other organic remains were observed either in these beds or in the chamber. But no very close search was made for them at the time, and the section was taken

from the surface of the bank, without attacking it with the pick-axe. The deposit bore all the characters of a bed of compact marine sand and gravel.

(*f.*) *Partition bed between upper and lower stories.*—The roof of the lower chamber was nearly flat, and consisted of huge blocks of limestone mixed with smaller angular fragments, the interstices filled up with gravel, and the whole cemented by stalagmitic infiltration into a strongly coherent mass. On the upper side ochreous loam replaced the interstitial gravel. The projecting ledge of this bed was about 6 feet thick, and sloped upwards to the mouth of the upper chamber, where the thickness was estimated to be about 14 feet. The materials corresponded in the general character with the bed of angular debris observed by Mr. Prestwich, on the raised beach of Mewslade Bay.

On the whole, 'Bosco's Den,' of all the Gower caves, furnishes the most complete succession of marine, brecciated, and alluvial deposits, disposed in a section of not less than 47 feet.

10. 'Bowen's Parlour' or 'Devil's Hole.' General Form and Dimensions.—Upper and Lower Chambers: swept out by the sea.

The cave named 'Bowen's Parlour,' by Colonel Wood, is known to the quarrymen of the neighbourhood by the name of the 'Devil's Hole,' from its singular and striking appearance. It is situated to the east of 'Crow Hole,' and between 'Crow Hole' and 'Bosco's Den.' Geologically regarded, it is one of the most interesting and instructive of the series, inasmuch as it is washed out, thus presenting as it were the skeleton framework of 'Bosco's Den' denuded of its deposits. Like the latter, it is situated in an angular fissure, narrow at the top and gradually expanding below to a width of 14 feet. The cave, which is about 40 feet high, is divided horizontally by a thick cake of stalagmite, concreting brecciated fragments of limestone into a solid diaphragm, so as to form an open chamber of about 20 feet high at the mouth, and extending back 53 feet, for the upper division; and under it, a lower chamber of about 14 feet in height. At high tides and with heavy south-westerly gales, the waves beat freely up into it, and the lower story is completely washed out; the outer thick part of the diaphragm remains forming a solid arch, but the reverberating action of the waves has operated with such force against the back part, that the central portion of the partition has tumbled in, leaving a gap in the floor of the upper chamber 16 feet long. A fine section of the calcareous breccia is thus exposed, showing that it was deposited

upon a bed of marine sand; thin tabular aggregations of sandy matrix adhere to the lower surface of the diaphragm, penetrated by attenuated irregular septiform plates of iron-tinted calcareous matter, forming a rude cancellar appearance. The sand is also permeated by calcareous infiltration. The upper chamber is likewise washed out, back to the extremity, and the floor is so free from any overlying matrix that it was compared by one of the quarrymen employed to a swept parlour floor. The denuding action of the sea is still in progress, and at no very distant period the segment of the horizontal partition now remaining will have been swept away. The rocky floor of the chasm is overlaid by a massive and stream-like sheet of stalagmite, which dates from the emptying out of the lower chamber, and is now in progress of formation. As above described of 'Bacon Hole,' a continuation of the cemented breccia can be traced upon the face of the cliff beyond the mouth, to a distance of many feet. The same phenomenon is repeated in 'Crow Hole.' The breccia corresponds in the character of the materials, as I have already remarked, with the angular brecciated debris, which overlies the raised beach, in the 'Mewslade Section' given by Mr. Prestwich. The penetration, so to speak, of this angular debris into the interior of so many of the Gower caverns, and its extension upon the face of the cliffs beyond their mouths are not a little remarkable, implying clearly something more than a mere local cause for the phenomenon. So far as I am aware, no such developed beds of breccia are met with in the caverns in the mountain limestone of the south coast of Devonshire.

I regard 'Bowen's Parlour' as an emptied repetition of 'Bosco's Den' or 'Raven's Cliff:' namely, that the bottom of the cave was originally filled with marine sand or gravel; that when this deposit was elevated above the reach of high water, stalagmite was formed upon the surface, enveloping the angular debris thickly strewed upon the sand; that upon the flooring so formed, cave-ochre or some of the other common alluvial materials, occurring in the contiguous caves, were injected through the fissure above, into the upper chamber; and that at last a converse action, of comparatively modern date, took place, by which the level of the cave was depressed, so that it was emptied of its contents both above and below the partition by the action of the sea. For reasons which will be adduced in the sequel, it is not probable that this effect could have been produced by the gradual encroachment of the sea upon a receding cliff which maintained a constant level.

No organic remains of any description were detected in 'Bowen's Parlour.'

11. 'Crow Hole' Cavern.—Description and Remains: imperfectly known.

This cavernous fissure, named 'Crow Hole' by Colonel Wood, is situated like the two last between the great caverns of 'Bacon Hole' and 'Minchin Hole,' and to the westward of 'Bosco's Den.' You descend from the plateau of highland surmounting the cliffs, for some distance, by the track leading to 'Minchin Hole,' and then go straight down by a very precipitous and perilous scramble on the crags, to about 60 feet above the level of the sea, to be landed on a rugged floor, something like that seen below the 'Yellow Top' cliff at Paviland. This leads to a ravine with diverging walls, the bottom of which is not roofed over, but presents a cliff about 43 feet high, composed of limestone breccia, chiefly small angular fragments, mixed with some large blocks. Below the breccia there is a confused mass of stalagmite, then ferruginous sand and gravel, again succeeded by breccia, resting upon a thick bed of coarse sand, of which a depth of 4 feet is exposed, free from admixture with stones. The width of the ravine where the cliff of cemented breccia terminates is about 27 feet, and a distinct line of the same materials can be traced upon the rock a considerable way out, as at 'Bosco's Den' and 'Bowen's Parlour.' Colonel Wood has exhumed from these deposits bones of *Ursus*, *Badger*, *Rhinoceros*, and some other remains, but the locality has not yet been sufficiently explored, and my acquaintance with the details is at present too imperfect to warrant my giving any further description of it; more especially as there is much complexity in the intercalation of the beds of sand and breccia, demanding careful examination. The angular breccia bed is here developed in great force; the section of it in the cliff above the ferruginous sand exhibiting a depth of 18 or 20 feet.

12. 'Raven's Cliff' Cavern.—Description: Floor-Beds, and Remains.

The cavern which he has called 'Raven's Cliff' has been the latest field of Colonel Wood's excavations, and it gives promise already of being one of the most productive in species of all the caves in Gower. It is situated in the cliff facing the sea to the west of 'Minchin Hole,' and between it and 'Shire Coom.' I examined the locality last September, in company with Colonel Wood, when it was intact. The cliff presented the section of a cavernous fissure completely crammed with sea sand in the same plain with the general face of the scarpment, and affording no indication whatever of an opening. Below and in front of it there

was a great talus of sand accumulated upon enormous masses of concrete breccia lying huddled in great confusion. The sand was removed 'in order to ascertain whether it was possible to penetrate into a cavern.' The operations were commenced in January last, and I am indebted to Colonel Wood's letter for the details which follow. After clearing away the bank of sand in front, a thin stratum of stalagmite was discovered stretching right across the fissure from wall to wall, and close up to the roof, there not being more than a foot of space intervening. They were occasionally formed by connecting pipes of stalactite. In this contracted channel two lower jaws of *Mustela foina*, decidedly new to the English fossil Fauna,[1] together with some fish-bones, were found resting upon the stalagmite; also several jaws of Foxes with some bird-bones. On pushing the excavation further in, a greater depth of sand was attained, amounting to 4 feet, when several very large balls of coprolites were encountered, indicating the presence of Carnivora. The following day some fine remains of *Felis spelæa* were discovered: among which were a fragment of the right upper jaw containing the carnassier and adjoining premolar *in situ*, also a very perfect upper canine, 5 inches long, some detached premolars, and two incisors. Proceeding inwards and still deeper, the lumbar vertebra of a Rhinoceros turned up, and close by it the vertebra of a fish, both encrusted with ferruginous sand, and in the same mineral condition. On digging down through the bed of sand, which attained an extreme depth of 9 feet, a second floor occurred, composed, as usual in the Gower caves, of angular fragments of limestone cemented together by calcareous infiltration, irregularly interspersed with concrete and detached pieces of stalagmite, and occasionally discoloured by ferruginous sand. At the bottom of the sand and resting upon this brecciated floor, a large block of limestone was laid bare, displaying the exposed surface and edges smoothed and polished by friction. The carboniferous limestone of Gower weathers everywhere into a rough honeycombed or unequal surface; and Colonel Wood infers that the polish upon this block was caused by the rubbing against it of large Carnivora, as in the pedestal of Zahnloch described by Goldfuss.[2] About 2 feet further in and beyond this block, the perfectly entire and anchylosed radius and ulna of a Rhinoceros were exhumed. The entire humerus and several vertebræ of an Elephant, together with

[1] These specimens of *Mustela* were carefully compared in the British Museum with *Mustela martes* and *Mustela zibellina*, also with various species of *Putorius*, and with *Zorilla Capensis* and *Mephitis Americana*.—[Ed.]

[2] Cited in Buckland's 'Reliquiæ Diluvianæ,' p. 132.

a fragment of a tusk, and remains of *Bos* and Deer, were also met with in the same deposit.

On clearing out the sand, which at the back part of the cave decreased in thickness from 9 to 3 feet, the deposit under the floor of concrete breccia was next examined. The breccia was found to vary from 9 inches to a foot in thickness; and, as usual in the other Gower caves, the traces of a continuation of it were seen extending seaward on the face of the cliff, many feet beyond the mouth of the fissure. The stratum below consisted of a very hard, dark-grey, gritty sand, attaining a maximum thickness of about 8 feet.

At present, in its excavated state, 'Raven's Cliff' Cavern exhibits a fissure, about 20 feet high at the entrance, and 29 feet in width. The walls gradually converge inwards, and the roof declines in the same direction, so that the extremity terminates in an angular contraction about 43 feet from the entrance, where the aggregate thickness of the deposits amounts to 18½ feet.

13. Paviland Cave.—Skeleton of 'Red Lady' and Elephant Remains.

The two cavernous fissures on the face of the cliff, below the very bold and grand escarpment which is called the 'Yellow Top Rock' are so well known, under the name of the 'Paviland Cave,' through the description given by Dr. Buckland, that on the present occasion I shall confine my remarks to a single point, namely, the human bones found in the cavern, and their presumable relation to the Elephant remains with which they were associated. An imperfect female skeleton, minus the skull, vertebræ, and extremities of the right side, but with the remaining parts asserted to have been found lying 'extended in the usual position of burial,' was discovered beneath a shallow covering of nearly six inches of earth, on the floor of the eastern cavern called the 'Goat's Hole.' The bones were stained red, by a kind of ruddle, 'composed of red micaceous oxide of iron,' in consequence of which the skeleton was distinguished in Gower by the name of the 'Red Lady of Paviland.' None of the fossil or other bones found in the contiguous deposits were stained in a similar manner. But numerous fragments of slender and smooth cylindrical ivory rods, and some portions of ivory rings, supposed to have been bracelets, also stained red, were exhumed in close contact with the skeleton. They were in a state of complete decay, brittle, and so tender as to be readily cut by the nail. In an adjoining bank, at a higher level, two Mammoths' molars were discovered, which I have examined, in the

collection of Miss Talbot, in Penrice Castle. They are very pronounced and characteristic specimens of the true Mammoth, *E. primigenius*. At a lower level, and at no great distance from the bones of the 'Red Lady,' a very considerable portion of the skull of an Elephant was discovered, comprising the sockets of the two tusks and a portion of one tusk two feet long. The tusk, like the stained rods, was in a state of advanced decay, and very brittle. Dr. Buckland inferred that the cylindrical rods, rings, &c., were 'certainly made from part of the antediluvian tusks that lay in the same cave.' If this assumption were well founded, there would be no escape from the conclusion, that the 'Red Lady' and the Mammoth had been contemporaneous or nearly so, for the ivory must have been fresh and hard when the rods and rings were shaped out of it. But similar rods and rings are met with in the barrows; it is known from history[1] that the ancient Britons imported them from France, and it seems more probable that the ivory ornaments of the 'Red Lady' were of the imported class, than that they were fabricated out of the Mammoth tusks that lay in the cave deposits.

14. Spritsail-Tor Cavern.

The double-mouthed cavern named 'Spritsail-Tor' is situated on the west side of Gower, facing Carmarthen Bay, and on the northern flank of the axis of Old Red Conglomerate. The carboniferous limestone strata have been denuded here to a narrow band, and the cave occurs in the projecting point, forming the northern boundary of 'Broughton Bay,' overhanging the Whiteford Sands. This cavern differs from all those on the south coast, in having its mouth's opening near the very summit of the cliff, which, together with a considerable portion of the crowning plateau, is buried under an immense accumulation of blown sand, that rises into hillocky downs in the 'Whiteford Burrows.' It was accidentally discovered in 1839, through the cutting back of a quarry in the carboniferous limestone.[2] On removing the sand a concealed cavern was discovered, which was partially explored at the time by Sir Henry de la Beche, and thoroughly opened in 1849 by Colonel Wood, who, during the progress of the operations, detected the second opening. The two apertures, which are low and angular, are about 13

[1] 'They (the Britons) pay but moderate duties on the imports and exports from Keltica, which are ivory bracelets and necklaces, amber, vessels of glass, and small wares, &c.'—'The Geography of Strabo,' translated by H. C. Hamilton and W. Falconer (1854), vol. i. p. 298.

[2] De la Beche, 'Geological Observer,' p. 303.

feet apart, and connected by a contracted passage parallel to the face of the cliff. The principal or eastern aperture is irregularly vaulted, expanded at the mouth, but suddenly contracting inwards into a shallow chamber of very limited extent.[1] There is still a great amount of stalactite drip from the roof, and the floor deposits were in relation to this condition. On the surface there was a layer of loose blown sand a foot and upwards in thickness, which lay upon a flooring composed of several distinct strata, throughout which bones, teeth, and splinters of the bones of various species of Mammalia were firmly cemented, forming a compact osseous breccia. Beneath the stalagmite, the irregular fissure of the rocky floor was impacted with cave earth or yellow ochreous loam, containing an immense accumulation of embedded bones. Among these were molar teeth, milk or adult, and other remains of Elephants, including both *Elephas antiquus* and *E. primigenius*; bones and teeth of *Rhinoceros tichorhinus, Equus, Sus, Bos, Cervus, Lepus, Arvicola, Ursus spelæus, U. priscus, Felis spelæa, Canis lupus, C. vulpes, Meles Taxus*, and *Mustela*. Detached carnassiers, premolars, and canine teeth of *Hyæna* were very numerous, together with fragments of lower jaws. Coprolites of the same species were met with. Bones of the extremities of *Bos, Equus*, and *Cervus*, broken up into massive gnawed splinters, exactly like those figured by Buckland, were found in large quantities. Detached molars of *Equus* and *Bos* were also excessively abundant, a sure sign of the den of *Hyæna spelæa*. In short, the contents of the cavern bore all the characters of a long-tenanted Hyæna's den. It is the most perfect illustration of the kind that I have seen, either in Gower or elsewhere among British caverns.

The contents of the chambers communicating with the two apertures were very much alike. When the western opening was laid bare, a fine specimen of the antler of a Reindeer presented itself, partly protruding through the sand, but lying free upon the stalagmite floor.[2]

In the eastern chamber, the entire femur of a young woman, together with the lower jaw of a child of about seven

[1] 'We were much struck by the narrowness of a part of the entrance, where predaceous animals, apparently Hyænas (*H. spelæa*) seem to have been stopped with large portions of the carcasses of *Rhinoceros tichorhinus*, numbers of the teeth of which, among the other remains, were accumulated close outside it.'—De la Beche, *loc. citat.*

[2] *Extract from Dr. Falconer's Notebook.*—'Major Wood found portion of an antler of Reindeer in Tor Hole; circumference of base 5½ inches. Beam, 18 inches long—retaining 4½ inches of brow-antler and 2 inches of bez-antler. The base of this horn and brow-antler were embedded in stalagmite, while the upper fractured extremity protruded through the cavern layer of sand, and a considerable portion of the beam was exposed. It was in a highly decomposed state.'—[Ed.]

years, were discovered embedded in the sand.[1] The cave loam yielded a prodigious quantity of the remains of two or more species of *Arvicola,* and other minute Mammalia. Among the rodents in this case I observed that lower jaws predominated very largely in number over crania and upper jaws, in the ejected materials which strewed the face of the talus below the aperture, and which still remained after ten years of exposure to the weather. The exact elevation of Spritsail-Tor above highwater mark has not yet been precisely ascertained. No trace of marine sand or gravel was detected. The absence of arenaceous deposits below the stalagmitic floor is not a little remarkable, considering how liable the chambers are to be filled with sand at the present day; and the circumstance indicates a very considerable change in the physical conditions around the cavern since the date when the stalagmitic flooring was formed. Although molar teeth of *R. tichorhinus* are abundant in 'Paviland' and 'Spritsail-Tor,' no remains attributable to *R. hemitœchus* were identified among the contents of either cave. One very finely preserved upper molar of *Elephas antiquus* was exhumed from the cave loam of Spritsail-Tor, together with some milk molars of the same species. It is worthy of remark, that the molars of *E. primigenius,* from the same cavern, the distinctive characters of which are strongly pronounced, commonly present a much fresher appearance with more animal matter retained in them.

15. General Remarks on the Distribution of the Mammalia in the different Caverns.

This concludes the description of the ossiferous caves. I append a tabular statement showing the genera and species of Mammalia which have been discovered in them. The list is remarkable for the great numerical richness of the species. With the exception of the *Drepanodon* (*Machairodus*) of Kent's Hole, it includes all the larger-sized carnivorous and herbivorous species that have been met with throughout the caves in England, while two of the species, namely *Elephas antiquus* and *Rhinoceros hemitœchus,* have not been heretofore described as occurring in any of them. Of the smaller-sized genera, it contains representatives of every one, with the exception of the *Lagomys* of the South Devonshire caverns, and of *Spermophilus,* the presence of which I have lately ascertained in the collections from the caves in the Mendip hills. The latter had not been known before as occurring in the Fossil Fauna of Britain.[2]

[1] On the authority of Mr. A Pytts Falconer and Colonel Wood, who inform me that the bones were thus identified by Professor Owen when sent to the Royal College of Surgeons.

[2] See *antea*, p. 452.

In the following Table, 1 *indicates that fossil was present;* x, *that it was abundant; and* o, *that it was absent.*

	Bacon Hole	Bosco's Den	Minchin Hole	Crow Hole	Raven's Cliff	Paviland	Spritsail-Tor	Long Hole[1]
1. Ursus spelæus	x	x	1	1	1	x	x	1
2. U. priscus?	o	o	1	o	o	o	1	o
3. U. Arctos	o	o	o	o	o	1 ?	1	o
4. Meles Taxus	1	o	o	1	1	o	x	1
5. Putorius vulgaris	o	o	o	o	o	o	1	1
6. P. ermineus	1	o	o	o	o	o	o	o
7. Mustela foina?	o	o	o	o	1	o	1	1
8. Lutra vulgaris	o	o	o	o	o	o	o	1
9. Canis lupus	1	x	x	1	1	x	x	1
10. C. vulpes	1	x	1	1	1	x	x	1
11. Hyæna spelæa	1	o	x	o	1	x	x	x
12. Felis spelæa	o	o	o	o	1	o	1	1
13. F. catus	o	o	o	o	1	o	o	1
14. Arvicola amphibius	x	x	x	x	x	x	x	x
15. Lepus cuniculus	o	o	o	o	o	o	o	1
16. L. timidus	o	o	o	o	o	o	1	1
17. Elephas antiquus	x	o	x	1	x	o	1	1
18. E. primigenius	o	o	o	o	o	x	x	1
19. Rhinoceros hemitœchus . . .	x	o	x	1	x	o	o	1
20. R. tichorhinus	o	o	o	o	o	x	x	x
21. Equus Caballus	o	o	o	o	1	x	x	1
22. E. Asinus	o	o	o	o	o	o	x	1
23. Hippopotamus major . . .	o	o	o	o	1	o	o	o
24. Sus Scrofa	x	x	x	1	x	x	x	1
25. Cervus euryceros (syn. megacerus)	o	o	o	o	o	o	1	1
26. C. (Rangifer) Tarandus . . .	1	x	1	o	o	x	1	1
27. var. (*a*) C. Guettardi . .	o	x	o	o	o	1	1	1
28. var. (*b*) C. priscus . .	o	x	o	o	o	1	1	o
29. var. (*c*) C. Bucklandi . .	o	1	o	o	o	1	1	o
30. C. Elaphus	1	o	o	o	o	1	1	1
31. C. Capreolus	1	1	o	o	o	o	1	o
32. C. (Strongyloceros)	o	o	o	o	o	o	1	o
33. Bison priscus	x	x	1	1	x	x	x	1

1. Common in most of the caves; rare or wanting in Raven's Cliff.

2. A very fine perfect lower jaw, right, *vide* Cuv., Pl. 189, fig. 6, from M.H., with two premolars close to canine, and narrow high coronoid.

3. Rare in the Gower caves generally; found in Spritsail-Tor (Paviland?).

4. Found low in the deposit in Bacon Hole; very abundant in Spritsail-Tor.

5. In Spritsail-Tor.

6. In Bacon Hole.

7. 'Marten' found in Raven's Cliff; 2 lower jaws on the Stalagmite, also in Spritsail-Tor.

8. Found in 'Long Hole.'—[Ed.]

9. Very common in most of the caves. (See p. 462.)

10. Skulls abundant in the antler deposits in Bosco's Den; common generally.

11. Very abundant in Spritsail-Tor, Paviland, and Minchin Hole; comparatively rare or wanting in the others.

12. Only found in Spritsail-Tor and Raven's Cliff; Coprolites very abundant in the latter.

13. In Raven's Cliff above the Stalagmite.

14. Arvic. amphibius; very common in all, the smaller species not observed.

15. Found in 'Long Hole.'—[Ed.]

16. Only 1 lower jaw of Hare found in Spritsail-Tor; and not looking very old.

17. Not found in Bosco's Den or Paviland.

18. Common in Paviland and Spritsail-Tor; wanting elsewhere.

19. Wanting in Bosco's Den, Paviland, and Spritsail-Tor.

20. Very abundant in Paviland and Spritsail-Tor; wanting in the others.

21. Very common in Paviland and S.-Tor.

22. Common in Spritsail-Tor.

23. Very uncommon, and limited to a few remains in Raven's Cliff.

24. Common in all the caves.

25. No antlers; but molar teeth in Spritsail-Tor only, and not abundant.

26. Very abundant in Bosco's Den.

27. Ditto ditto

28. Ditto ditto

29. In Bosco's Den, Paviland, and Spritsail-Tor.

30. In Bacon Hole, Paviland, and Spritsail-Tor.

31. In Bacon Hole, Bosco's Den, and Spritsail-Tor.

32. In Spritsail-Tor.

33. Common in all the caves.

[1] 'Long Hole' not discovered at date of paper. See page 538. [Ed.]

When the eye is cast over the contents of the different columns, some remarkable points of contrast are observable. Thus, in 'Bacon Hole,' 'Minchin Hole' and 'Raven's Cliff,' *Elephas antiquus* and *Rhinoceros hemitœchus* occur in the two first in great abundance; while in Paviland they are supplanted by *E. primigenius* and *Rhinoceros tichorhinus*; the other associated genera and species being, as a general rule, the same. It is further remarkable, that these localized species do not *ordinarily* occur intermixed, the only well-marked exception being in the case of 'Spritsail-Tor,' where both *E. antiquus* and *E. primigenius* have been found. But neither in Paviland nor in 'Spritsail-Tor' was a single molar or jaw fragment of *Rhinoceros hemitœchus* encountered, nor of Rhinoceros *tichorhinus* in 'Bacon Hole' or 'Minchin Hole.' I passed all the Rhinoceros remains of the Gower collections under a very close scrutiny, expressly with a view to the determination of this point, and considering the abundance of fossil teeth of both species, in the caverns in which they respectively prevail, the contrasted distribution was very strongly brought out. It should at the same time be remembered, that 'Spritsail-Tor' fulfils the conditions hypothetically put by Mr. Prestwich in the appendix, in being a cavern, situated near the summit of the cliff, and probably at a higher level above the sea, when marine sands were laid upon the floors of 'Minchin Hole' and 'Bacon Hole.' Detached molar teeth in great abundance and other bones referable to at least two species of *Equus* go in company with remains of *R. tichorhinus*. They were very numerous in 'Spritsail-Tor,' but rare in 'Bacon Hole.' Their prevalence in the former is explicable on the supposition, which all the conditions confirm, of its having been long used as a Hyæna's den: the hard prismatic teeth of the horse having been rejected, when the jaws that yielded them were crunched and devoured.

The distribution of *Elephas antiquus* in England, and over the greater extent of the European area south of the Rhine, is now pretty well ascertained. I found it in very considerable abundance in the collections from the bone-caves in the vicinity of Palermo, and also in some of the newer deposits of the Valley of the Anapus upon the south coast of Sicily near Syracuse.[1] In the environs of Rome it occurs in the marine volcanic Tuffs, or volcanic gravels of Monte Verde, Monte Mario, Tor di Quinto, Monte Sacro, La Magliana, Ponte Molle, and other corresponding localities, in great numbers. I observed in the Museum of La Sapienza, and in the private collections of Professor Ponzi and Signor Ceselli, of Rome, various undoubted molars of all ages of the

[1] See *antea*, p. 188 – [Ed.]

true *E. primigenius*, from Ponte Molle, Monte Mario, and Monte Sacro, near the Ponte Nomentano. They were from the same tufaceous deposits which yielded the remains of *E. antiquus*, and the accuracy of the assigned localities was placed beyond question, by the matrix which covered the Mammoth molars presenting abundant grains of Pryroxene and decomposed Amphigene which characterize the volcanic Tuffs around Rome. *E. antiquus* occurs also in the Val d'Arno and in the Valley of the Po. The range of the species which I have named *Rhinoceros hemitœchus*, both geographically and in time, has not yet been so precisely determined. In England it occurs in the Clacton-beds so perseveringly examined by the late Mr. John Brown of Stanway, at Folkestone, and in some upper tertiary deposits in Northamptonshire. It is not a little singular that the prevailing fossil Rhinoceros of Grays Thurrock, of which the remains are found in very great abundance, belongs to a species which I regard as being entirely distinct from the *Rhinoceros hemitœchus* of Clacton and the Gower caves.

Of the large Carnivora, Bears, chiefly *Ursus spelæus*, were found in all those caverns. Remains of *Canis lupus* were also very abundant throughout; and in 'Bacon Hole' there was distinct evidence of their occurrence, in the cave earth below the second stratum of stalagmite, mixed up with bones of *Hyæna spelæa*, *Rhinoceros hemitœchus*, and *Elephas antiquus*. *Hyæna spelæa* was most abundant in 'Spritsail-Tor' and 'Paviland,' but comparatively rare in 'Bacon Hole,' 'Minchin Hole,' and 'Raven's Cliff,' and entirely wanting in 'Bosco's Den.' In 'Raven's Cliff' the ulna of a Hyæna was found covered with large superficial patches of the slender burrowed canals, described by authors under the name of *Talpina*, which has also been observed on fossil teeth from Malta, and on the enamel of the molars of *Dinotherium* from Miocene beds in India. Remains of *Felis spelæa* are rare in the Gower caves; they turned up only in 'Spritsail-Tor' and 'Raven's Cliff.' *Meles Taxus* occurred in 'Bacon Hole,' 'Spritsail-Tor,' 'Crow Hole,' and 'Raven's Cliff,' and the remains yielded several finely preserved crania and lower jaws; in 'Bacon Hole' traces of it were found, in the deeper deposits, along with *E. antiquus* and *R. hemitœchus*.

Of *Hippopotamus major* a few teeth only were found, at a low level in the sand beds of 'Raven's Cliff,' the most characteristic being a third milk molar closely resembling the Kirkdale specimen figured by Buckland in the 'Reliquiæ Diluvianæ,' Pl. XIII. fig. 7, one perfect premolar of an adult and a portion of another, together with some nearly fœtal teeth. The occurrence of this huge extinct species of

Hippopotamus within the precincts of Gower is not a little remarkable, considering that at the present day there is nothing resembling a lake or the relics of one, in the peninsula, and that the largest existing stream, namely, the 'Pennard,' does not exceed the dimensions of a small brook. There are no grounds to believe that the few remains of *Hippopotamus* in the cavern of 'Raven's Cliff' were transported there from a distance, more than in the case of any of the other large herbivorous animals found in it; and the difficulty of explaining how they came there is best expressed by stating, that the confined peninsula of Gower, destitute either of lakes or of large streams of fresh water, is one of the last localities where the remains of *Hippopotamus* might have been looked for, consistently with what we know of the habits of the living species, and of *H. major*, where it has been found in the greatest abundance, namely, in the vicinity of extensive lacustrine deposits, like those of the Val d'Arno.

The most singular point connected with the distribution of Fossil Mammalia in the Gower caves is the immense quantity of Deers' antlers referable chiefly to *Cervus Guettardi*, which, as already stated, were encountered in 'Bosco's Den.' The fauna yielded by that cavern is more restricted in species than that of almost any of the others, being confined to species of Bear (*Ursus spelæus*), Wolf, Fox, Arvicola, Bos, and Deer, the last of which turned up in very great abundance. Between one thousand and eleven hundred distinct antlers were collected, the great majority of them shed, more or less fractured, chiefly of young animals; some of them much rolled, but hardly any presenting marks of having been gnawed. Buckland inferred, that the cave of Kuloch in Germany contained the remains of 2,500 Bears of the species *Ursus spelæus*, the calculation having been founded upon the quantity of animal matter found on the floor of a single vault; and last year I brought before the Geological Society proofs of the enormous number of Hippopotami, within and outside the mouths of some of the caves in Sicily. The antlers of 'Bosco's Den' belong to the same class of extraordinary numerical accumulations. To appreciate to its full extent the singularity of this case, it ought to be remembered that 'Bosco's Den' is not an isolated cave, forming the sole receptacle for the remains of a large district, but that it is in close vicinity to a group of ossiferous caverns, like 'Crow Hole,' 'Raven's Cliff,' 'Bacon Hole,' and 'Minchin Hole,' in none of which was anything approaching the same number of antlers observed. On the contrary, they were rare.

Of other Ruminants, remains of *Bos* (*Bison*) *priscus* were abundant in all the caverns. They occurred in 'Bacon Hole,'

along with *Elephas antiquus*, *Rhinoceros hemitœchus*, *Hyœna spelœa*, &c. in the cave loam at the lower part of the section, and also at a low level in 'Raven's Cliff.' No bone of *Bos* (*Ursus*) *primigenius* was satisfactorily identified; but the comparison of the large Bovine remains has not yet been sufficiently carried out to warrant any definite statement on the point. Molar teeth referable to the Irish Elk (*Cervus eurycerus*) were exhumed from 'Spritsail-Tor'; and antlers, together with crania from which the horns had been shed, of Reindeer, from the same cave and Paviland. Horns of *Cervus Elaphus* and *C. Capreolus* were encountered in the superficial earth covering the floor of 'Bacon Hole.' Some of them bore distinct marks of having been chopped rudely, or partially cut.

Remains of *Arvicola amphibius* were met with in great abundance, in 'Spritsail-Tor,' 'Bosco's Den,' and 'Bacon Hole;' in the last at the very bottom of the floor deposits. Detached incisors and molar teeth are seen attached to a specimen comprising the radius and ulna of *Rhinoceros hemitœchus* from the lower deposits of Raven's Cliff, and encrusted with the original matrix. Doubts have been raised whether the presence of *Arvicola amphibius* along with extinct animals in the caves might not be explained by the known burrowing habits of the species. But the specimen in question clearly indicates that it was a cotemporary of the Rhinoceros.

16. Geological Age of the Gower Caves.

In the spring of 1858, on my first visit to Gower, I was struck with the significance of the fact, that marine sands containing common existing shells lay at the bottom of the ossiferous deposits in 'Bacon Hole' and 'Minchin Hole,' tending, so far as the limited evidence went, to assign a very modern date in the Pliocene period, for their emergence above the sea and subsequent filling up. On the other hand, when I came to examine in detail the fossil bones, I was equally struck with the fact that the remains of *Elephas antiquus* and *Rhinoceros hemitœchus*, the latter especially, were very abundant in both caverns; while not a single bone referable to *E. primigenius* or *R. tichorhinus* could I detect in either. The Gower species of *Rhinoceros* (*R. hemitœchus*) was then new to me; but I found it associated with an Elephant, which I had hitherto regarded as a characteristic form of the 'Elephant-bed' that underlies the 'Boulder-clay' on the Norwich coast, of the Sub-Apennine beds of the Astesan, of the 'Mud-bed' of Bracklesham Bay, and of 'Grays Thurrock.' Here then were two lines of seemingly antagonistic evidence: the marine sands and their contained shells, indi-

cating a comparatively modern date, while some of the mammalia tended to put the ossiferous beds of the caverns back to a period not far removed from that of the Norwich Crag. On examining the bone collections from 'Paviland' and 'Spritsail-Tor,' the perplexity of the case was increased by my observing among them conditions in some respects precisely the converse of what I had seen in 'Bacon Hole' and 'Minchin Hole.' Remains of *R. tichorhinus* were comparatively abundant both in 'Paviland' and in 'Spritsail-Tor,' while the species occurring in 'Bacon Hole' and 'Minchin Hole' was wanting. On the other hand, remains both of *Elephas antiquus* and *E. primigenius* were encountered in 'Spritsail-Tor,' while, as a general rule, the associated herbivorous and carnivorous genera and species were, with certain local anomalies, the same throughout the caverns. Hence the question was suggested: 'Does this limited peninsula of Gower comprise ossiferous caves referable to distinct geological periods? or are all the mammalian remains contained in them referable to one and the same period?'

On paying a second visit to Gower, in the autumn of 1858, I became acquainted with the fact, that transported blocks occurred on the highland of Cefn Bryn, and I observed beds of gravel on the southern slope of the old red sandstone conglomerate. I became very desirous that these boulders and gravels should be examined by some observer of authority, having special familiarity with that walk of investigation, and in discussing with my friend Mr. Prestwich the various bearings of the Gower case, I impressed upon him the importance of his paying a visit to the cave district. This object he accomplished last autumn, and the results are given in the notes hereto appended, with which he has favoured me.

But in the interval between my first visit, in 1858, and Mr. Prestwich's late reconnaissance of the Gower district, I had opportunities of examining the cave collections of the Mendips in the Museum at Taunton and in Mr. Beard's possession near Banwell, the remains of the Devonshire caverns at Torquay and Plymouth, the Durdham Down collection at Bristol, the Cefn collection formed by the late Mr. Lloyd and now in the possession of Colonel H. W. Williams Wynne, and the Kirkdale collection at York, besides gleanings from all these and other localities in the British Museum and in the rich collection left by Buckland at Oxford. I had also seen the indubitable remains of *E. antiquus* and *E. primigenius*, associated in the beds of marine volcanic Tuffa, at Monte Sacro and other localities in the environs of Rome. The result was to prepare me for a great change of opinion

and for the conviction, that notwithstanding apparent anomalies in the restriction of certain species to certain caves, all the extinct mammalia of the Gower caverns might belong to one Fauna, and to the same unbroken geological period.

There cannot be a doubt that the thin beds of marine sand in 'Bacon Hole' and 'Minchin Hole,' containing the association of *Litorina litorea*, *L. litoralis*, and *L. rudis*, were deposited on the floors of these caverns before they rose above the level of the sea.[1] The ossiferous beds are in immediate and undisturbed superposition upon the sands, and it would seem clear that they belong to the same period. The species of large Pachydermata, Ruminants, and Carnivora, were living upon the emerged land of Gower before the floor of the caves rose above the level of the sea; but the great accumulation of their bones now seen in the cave deposits took place during a long lapse of time after the rise had been accomplished.

The raised sea-beach of Mewslade Bay, and the marine sands and gravels of 'Bacon Hole' and 'Bosco's Den' are so nearly in the same line of section, and they differ so little in level, that there is hardly any room to doubt that they belong to the same series of deposits, and to the same period of upheaval. The species of mollusca found in the raised beach are more numerous than those that were detected in the caves; but the three species of *Litorina* were common to both, and all the forms are of prevailing recent species.

Mr. Prestwich has expressed his opinion in very guarded terms upon the evidences of the Boulder-clay deposit on the highland of Cefn Bryn, and in Rhos Sili Bay, and on its relation to the caves and raised beach. But I am fully prepared to accept the inference, to which that cautious observer leans, that they would both appear to be of a more recent date than the Boulder-clay.

Proofs of the comparatively modern epoch of the cave deposits and raised beach may also be inferred from the slight amount of inroad which the sea has made upon them since the period of their deposition. A mile of raised beach still survives in Mewslade Bay, perched, as Mr. Prestwich felicitously expressed it, upon the out-cropping edges of the limestone strata of the old cliff, which is but very little changed in the shape of its escarpment since the beach was formed, although still in close proximity to the sea. The line of coast in which the group of ossiferous caves between 'Bacon Hole' and 'Minchin' are situated presents a broadside to the waves of the Bristol Channel. These caves overhang

[1] Mr. Starling Benson distinctly refers to the bed in Bacon Hole 'as the remains of an ancient littoral beach found below the cave deposit.'—Account of the Cave-Deposit of Bacon Hole, p. 15.

the existing beach, and they contain groups of individuals of species of *Litorina*, associated upon the cavern floors apparently, as they were when alive. It is in the highest degree improbable that these mollusca could have lived in distant recesses of the caves, accessible to the waves, but far removed from light. They must have been in close proximity to the mouths of the caverns then, as they are now, showing that in this case also sufficient time has not yet lapsed to admit of any considerable recession of the cliffs by the wasting action of the sea. Denudation is visible in the indentations of Swansea Bay and Oxwich Bay upon the softer strata of the coal measures; but of a date long anterior to the Cave period.

The next point which suggests itself for inquiry is: are there any indications of a general subsidence of the coast line, or of local depression in the vicinity of the caves? Mr. Starling Benson cites, in support of this idea, as an established fact, 'the well-known remains of large trees, now several feet under high-water mark, in Swansea Bay.'[1] Colonel Wood informs me that there are evidences along the whole line of coast, from Swansea to the eastern point of Oxwich Bay, of submerged forests; stumps and trunks of trees being occasionally exposed by the action of the tidal currents. I have stated above, that the marine deposits in the caves are not at a uniform level, either in relation to each other or to the Mewslade raised beach. The floor of 'Bacon Hole' is fully 30 feet above high water, and above the reach of the waves in the heaviest gales. The marine deposits in 'Bosco's Den' have been washed out to a depth of 31 feet back from the mouth, the waves having free access to the interior during high tides. In 'Bowen's Parlour' both the chambers, upper and lower, have been completely swept out, the solid dividing floor of cemented breccia alone remaining of all the former deposits. If the sea has not encroached much, and the cliffs receded, these appearances are only explicable on the supposition that there has been a depression affecting at least the cited caves.

That the newest of the cave strata have been subjected to at least one violent shock is clearly proved by the rent and shivered condition of the stalagmitic boss of 'Bosco's Den'; and it is equally clear, from the uncemented state of the fragments, that this shock is of a very modern date, and subsequent to the commencement of the date of deposition of the superficial layer of sandy peat, which covers the floor. The late Mr. Stutchbury observed in 'Durdham Down' a dislocation in a vein of spar, which led him to the belief that

[1] *Op. citat.* p. 16.

a relative movement of the walls of the cavern had taken place since the accumulation of the bones within it. I examined, in the Bristol Museum, a very remarkable specimen of a lower molar of *Elephas antiquus* from the same cave, in which the three anterior plates of the crown were undisturbed, while a fault passed diagonally through the next five plates, involving a difference of level on the opposite sides of the dislocation, to the extent of an inch. The fissure was filled with stalagmitic loam. In the same collection I observed a large upper molar of Hippopotamus, presenting a vertical fissure and fault, running transversely, the opposite ends overlapping alternately. These appearances are only explicable in the manner suggested by Mr. Stutchbury, and they belong to the same class of phenomena as the rent boss of 'Bosco's Den.' Distinct evidence of modern subsidence has been found in Torbay, in the submerged peat or forest-bed in front of the Torre Abbey Ground, near Torquay, and along other points of the coast in the vicinity, while on the opposite points of the bay there are patches of raised beach, with ossiferous caves in the vicinity, repeating the conditions which are presented on the south coast of Gower. On the whole, if not proved, it appears at least highly probable, that some of the Gower caves have undergone a depression of level.

One of the most interesting geological phenomena among the newer deposits in Gower is the enormous development upon the cliffs along the coast of the 'Brèche en place,' or angular debris, to which Mr. Godwin-Austen has applied the name of 'Head.' I have had constantly, throughout the descriptive details of the caverns, to refer to its presence, sometimes in vast accumulations, in the immediate vicinity of the caves, and to its intrusion, so to speak, into their interior, as a flooring cemented by stalagmite, overlying the marine sands and stretching seaward upon the face of the cliffs. The origin of this angular debris and the rationale of the accumulations are at present involved in the greatest obscurity, seeing that some, like Mr. Godwin-Austen, regard it as being a sub-aerial deposit, while other able observers view it as an aqueous deposit, the result of tumultuous transport. It is not my intention to enter upon the question here, but simply to call attention to the fact, that there is probably no part of the South Coast of England in which the phenomena are developed upon a greater scale, nor can be studied with greater advantage, than in the peninsula of Gower.

17. Comparison of the Gower Cave Fauna with that of other Cave Districts in England.

Assuming, as a position, that the Gower caves are of a comparatively late date, it may next be inquired: are there any proofs, in any of the other caves in Britain, of a Mammalian Fauna of an older date? The full discussion of this subject, involving numerous comparisons, would extend far beyond the limits within which this communication is restricted, and I must deal with it very briefly. Some of the species are nearly constant in all the caves, both in England and Germany, such as *Ursus spelæus*, *Hyæna spelæa*, and *Felis spelæa*; and these are commonly associated with *Elephas primigenius*, *Rhinoceros tichorhinus*, *Bos primigenius*, *Bos* (*Bison*) *priscus*, and large species of *Cervus*, such as *C. eurycerus* (the Irish Elk). But in some of the caverns the latter series is supplanted by *E. antiquus*, *Rhinoceros hemitœchus*, and *Hippopotamus major*. The most remarkable case running parallel with 'Bacon Hole' and 'Minchin 'Hole,' with which I am acquainted, is the cavernous fissure of Durdham Down, described by Mr. Stutchbury. I have carefully examined the collection preserved in the Bristol Museum, and distinguished 15 molars of all ages of *H. major*, besides an incisor canine and calcaneum. These were associated with a series of upper molar teeth of *R. hemitœchus*, and with *molars* of *E. antiquus*, together with remains of *Ursus spelæus*, *Ursus arctoides* (?), and *Hyæna spelæa*. In the Mendip caves (Banwell, Hutton, Uphill, Bleadon, Berrington, &c.), *E. primigenius* and *R. tichorhinus* are common, together with *Felis spelæa*, *Hyæna spelæa*, &c. *E. antiquus* is rarer, and I did not observe a single specimen referable to *R. hemitœchus*. I detected in the Rev. D. Williams' collection, in the Taunton Museum, two lower jaws of a species of *Spermophilus* (tailless Marmot), from some one of the Mendip caves, new to the fossil Fauna of England.[1] In the collections formed by McEnery, from Kent's Hole, *E. primigenius* and *R. tichorhinus* are very common, while *E. antiquus* and *R. hemitœchus* appear to be wanting. The most remarkable peculiarity of the Kent's Hole series is the presence of a species of *Machairodus*, which has nowhere else been found in England. The *Lagomys* of Kent's Hole has lately turned up in the Brixham Cave. Of the Kirkdale specimen the young Elephant's molar, represented in fig. 1 of Pl. VII. of the 'Reliquiæ Diluvianæ,' belongs to *E. antiquus*, and fig. 3 of the same plate to *R. hemitœchus*. I have examined the original

[1] See *antea*, p. 452.—[Ed.]

specimens in the Clarendon Museum at Oxford. Along with these were found some teeth of *Hippopotamus*.

18. Concluding Remarks and Inferences.

The comparative illustrations here given are taken from nearly all the principal ossiferous caverns of England, and they furnish no evidence of a Cave Fauna older than that of the Gower caves.

But there are some weighty objections to be explained. The Boulder-clay of the Norwich coast is in direct superposition to the 'Elephant' or 'Submerged Forest' bed at Happisburgh and Mundesley, which has been cited by all authorities as yielding remains of Elephants, Rhinoceros, and Hippopotamus. I found that the Elephants belonged to two species *E.* (*Lox.*) *meridionalis* and *E. antiquus*. The former has nowhere in England been found at a higher level than the 'submerged forest,' while the latter occurs abundantly in the Mud-bed of Bracklesham, in Grays Thurrock, and other localities in the Valley of the Thames. In like manner, the *Rhinoceros* which prevails in the 'submerged forest' belongs, as I have ascertained by recent investigation, to a species, *R. Etruscus*, which occurs very abundantly, in company with *E. meridionalis*, in the deposits of the Val d'Arno; but which, in England, like *E. meridionalis*, is never seen above the level of the Norfolk 'Elephant-bed.' The remains of the two Elephants have never, I believe, been discovered together *in situ* in this deposit. Although occurring in immense abundance, they are either brought up by the dredge from the Oyster Bank, or found stranded on the beach after heavy equinoctial gales. Molars of *E. antiquus* are also dredged up on the Essex coast, off the 'West Rocks.' There were a great many found thus, in the collection of the late Mr. Brown, of Stanway, but I never saw any molars of *E. meridionalis* among them. It is possible, therefore, that the molars of the two species found under the sea, on the Norwich coast, may be derived from beds of different ages. On a review of the general bearing of the evidence, it appears to me that the following conclusions are consistent with the existing state of our knowledge:—

1. That the Gower caves have probably been filled up with their Mammalian remains since the deposition of the Boulder-clay.

2. That there are no Mammalian remains found elsewhere in the ossiferous caves of Britain referable to a Fauna of a more ancient geological date.

3. That *Elephas* (*Loxodon*) *meridionalis* and *Rhinoceros*

Etruscus, which occur in, and are characteristic of, the 'Submarine Forest-bed,' that immediately underlies the Boulder-clay, have nowhere been met with in the bone caverns of Britain.

4. That *Elephas antiquus* with *Rhinoceros hemitœchus*, and *E. primigenius* with *R. tichorhinus*, though respectively characteristic of the earlier and later portions of one period, were probably contemporary animals, and each of them were certainly companions of the *Cave Bear*, *Cave Lions*, and *Cave Hyænas*, &c., and of some at least of the existing Mammalia.

APPENDIX TO MEMOIR ON THE CAVES OF GOWER.

I.—Letter from Mr. Prestwich on the Boulders and Gravels of the Gower Cave District, and on a Raised Beach to the West of Gower.

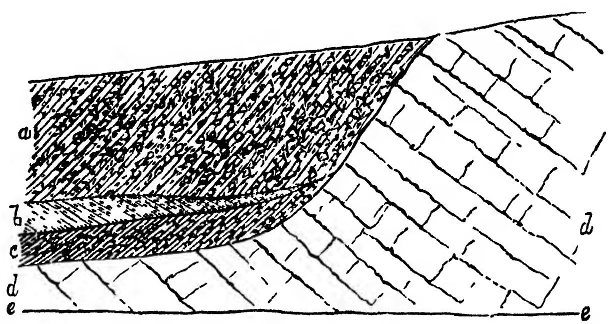
10 Kent Terrace, May 17, 1860.

My dear Falconer,—I have much pleasure in giving you a few lines respecting the raised beach I met with last autumn, to the westward of Paviland Cave in Gower. I find my notes on the subject are not very complete, having taken only a first survey, reserving a fuller examination of the coast until I could obtain access to the caves. You will remember how I was baffled on the last occasion by the state of the tide and the weather. Finding it quite impossible to pass round the foot of the cliff to gain the entrance to Paviland Cave, I proceeded westward along that iron-bound and magnificent frontage of limestone cliffs, ending in Worm's Head, with the intention of examining them at the accessible points, to see whether I could detect any facts bearing upon your very important observations on 'Bosco's Den,' relating to the connection of marine remains under, and in association with, the wonderful mass of bone debris you and Colonel Wood had discovered there. At the distance of about half a mile west of Paviland Cave I found a gully, by which I got down to the shore. I then found in hollows in the cliff, and at an elevation of 10 to 12 feet above the beach, a layer of sand and rolled limestone pebbles, having all the characters of a beach; but in the absence of shells, and looking at its small patchy character, no conclusion could be drawn from it alone. The passage at the foot of the cliffs being still impracticable, I had to confine myself for the next mile or two to one or two descents, where I again found traces of what appeared to be a raised beach. Still I was not prepared for the very fine and remarkable exhibition I witnessed, after passing Mewslade, at the bottom of the small bay formed by Thurba Rock and Tears Point, about one mile south of Rhos Sili. There, perched upon the escarped edges of the grey, weathered limestone, is an old beach, raised some 10 to 12 feet above high tide mark. It is composed of pebbles and fragments of limestones, thinly mixed with a coarse red sand, and in places full of shells and fragments of shells. There are very few species; the *Patella vulgata* is common;

the *Littorina litorea* abounds; there are a few *Purpura lapillus*, and fragments of *Mytilus*; also pebbles of limestone drilled by boring shells. The whole, which is 3 to 4 feet thick, is agglutinated into a semi-compact mass, and is overlaid by a remarkable mass of angular debris, from 20 to 30 feet thick in some places. The beach goes back only a few feet, as the limestone hill rises immediately behind. Coastways the raised beach continues almost uninterruptedly, but diminishing in importance, for half a mile westward, ending before reaching Tears Point. Its level is persistent throughout. The sketch I gave you at the time (fig. 4) is, I believe, nearly correct, and at present I do not think I could improve upon it, not having made sufficiently full notes.

Taking this in connection with the well known *raised beach* at the Mumbles, I think it may have an important bearing, in conjunction with your discoveries in those Bone Caves in Gower, which are situated on the coast between these two points. They are evidently on

FIG. 4.



RAISED BEACH AND OLD CLIFF NEAR MEWSLADE, GOWER, S. WALES.

a. Unstratified angular limestone debris, in a matrix of red sand and clay, 21 to 27 feet. *b.* Red sand and clay without shells, 4 to 5 feet. *c.* Rolled shingle with shells in places, 3 to 4 feet. *d.* Limestone rock. *e.* Level of present beach.

about the same level, and you have found in them sand and sea-shells under all the bone remains. Should it prove, therefore, that the caves are of this Raised Beach period, and that the Elephant and other remains have been subsequently introduced, we shall arrive at the interesting and curious conclusion that this particular group of mammalia lived after the formation of those beaches—beaches which have always been considered as of very recent origin, as they contain nothing, so far as they have been examined, but the commonest shells of our coasts. At the same time, it is to be observed that they contain but very few species, and that no complete and thorough investigation of them has been yet made. With regard to your suggestion in connection with the two species of Elephant, I must confess that I saw nothing in the physical features of the scene, during the somewhat hurried and imperfect view I had of it, to lead me to suppose that the caves, or rather their inhabitants, might be referred to two periods. I should hardly have hazarded this opinion, without a further examination of the district; but I give it for what it is worth, and waiting further data.

With respect to the point I had particularly in view, viz. the relation of the Gower Caves to the Boulder-clay, I am unable as yet to form a decided opinion. I got the Boulder-clay within a mile of the raised beach, but on *opposite* sides of the point of Rhos Sili. It spreads from the sea-shore to, as you are aware, the top of the hills. In Rhos Sili Bay I found intercalated in it, at an elevation almost exactly corresponding to the raised beach on the opposite side of the promontory, a bed of shingle containing several species of recent shells, but not one of the species occurring in the raised beach. Yet the two would appear to be synchronous; the difference might arise from the one being on an exposed and open coast, and the other in a sheltered bay. The subject requires a fuller and more lengthened inquiry. (J. PRESTWICH.)

II.—NOTE ON THE OCCURRENCE OF WROUGHT FLINTS, IN ASSOCIATION WITH TWO EXTINCT SPECIES OF RHINOCEROS, &c., IN 'LONG HOLE' CAVE, GOWER.[1]

On May 30, 1860, I communicated to the Geological Society a memoir on the Ossiferous Caves of Gower, founded on the joint researches of Lieut.-Col. Wood and myself. The main object of that communication was to show first what the Fauna of these caves was, as compared with the other ossiferous caves of Britain. 2. The presence in it of species of Elephant and Rhinoceros, which had not previously been recognized as occurring in the ossiferous caves. 3. The continuity, in the Gower Fauna, of Upper-Pliocene and Glacial mammals, without an apparent break; and lastly, the epoch whence the Gower Fauna dated. Some of the conclusions arrived at met in discussion with sharp criticism and opposition from leading authorities on the newer Pliocene and Drift deposits. Being desirous of concentrating attention on the points above indicated, I purposely excluded, with a single exception, from that memoir any reference to the then newly-agitated question, which attracted at the time, as it now does, so much attention, namely, the bearing of the Gower Cave evidence upon the antiquity of man. That exception was the presumable age of the famous human skeleton, so familiarly known, through the writings of Buckland, as the 'Red Lady' of Paviland, found associated, under questionable circumstances, with the skull of *Elephas primigenius*; and the inference drawn was against their having been cotemporary individuals Lieut.-Col. Wood and myself had found numerous wrought flints and some bone weapons in Paviland; but the cave deposits there had been so disturbed by previous excavations of an old date, that none of the instances was free from the taint of suspicious occurrence. As a rule, the Paviland flint-flakes were undistinguishable in form from those of the Grotto of Maccagnone.

Last autumn (1861) Lieut.-Col. Wood discovered a new ossiferous cave in Gower, which supplied conclusive evidence respecting the con-

[1] This paper was commenced in 1862, but was never completed. The deficiency has been made up from the author's Note-books. One of the main facts, however, contained in the paper was published by Dr. Falconer in the 'Annals and Magazine of Natural History,' for October, 1864, in a brief notice entitled 'On the Asserted Occurrence of Flint-knives under a skull of the extinct Rhinoceros hemitœchus in an ossiferous cave in the peninsula of Gower.'—[ED.]

temporaneity of the two extinct species of Rhinoceros of Gower, a point before open to question, and which at the same time appeared to throw light upon the relation of man to the extinct Fauna. This cavern, called 'Long Hole' by the neighbouring farmers, is situated in the line of cliffs called the 'Yellow Top Rocks,' about a mile west of the village of Port Eynon, and about one mile east from the Paviland Caves. It occurs near the summit of an interruptedly escarped limestone rock, facing the sea. Below, a precipice rises vertically, from the reef forming the shore, to the height of 51 feet. From its summit a steep slope, patched over with vegetation, stretches upwards and backwards, along a distance of 258 feet, and with an inclination of about 25°. Above this scarp another rugged precipice rises to a height of 20 feet, its summit being continuous with the surface of the country. The cave forms a low, irregularly arched aperture, in a scooped bight of the upper precipice, at its base, and is easily accessible from the plateau above, by a short descent and then doubling round the limestone bluff which bounds the cave towards the west. From an observation with an aneroid barometer, the cavern is about 130 feet above ordinary high-water mark. It occupies the uppermost part of a cleft, which, as in the case of 'Bacon Hole,' 'Bosco's Den,' and other of the Gower Caves that are situated on the sea cliffs, can be traced down upon the littoral reef which is exposed at low water. The segment below the scarp of this fissure is filled with a mass of gravelly conglomerate, forming a perpendicular cliff 50 feet high, which readily disintegrates when washed by the waves that are driven against its base, during the highest spring tides, aided by south-westerly gales. The top of the section is overlaid by a thin covering of limestone breccia, consisting entirely of angular fragments of local origin, called 'Wark' by the quarrymen, and corresponding with the 'Head' of Austen and other writers. This 'Wark' is enormously developed in the neighbourhood of Bacon Hole and some of the other caves. At the base of the gravel section, and perched about a foot above the mark of the highest spring tides, lies a huge detached and residuary tabular mass of the old sea beach, observed west of Mewslade by Mr. Prestwich.

'Long Hole' opens towards SSE., and is visible from the sea, which circumstance led to its exploration. When discovered the aperture presented an irregularly arched low fissure, 7 feet 8 inches wide by $4\frac{1}{2}$ feet high, which extended inwards about 44 feet.[1] At a distance of $8\frac{1}{2}$ feet from the entrance, the cave widens to 12 feet; this also is the highest point of the cave, the height being 7 feet. Passing inwards the passage contracts, the width varying from 4 to 7 feet, although at some places it was at first reduced to $2\frac{1}{2}$ feet from the projection inwards of stalagmitic bosses. The floor inclines upwards towards the extremity of the cave. The roof is horizontal, but very irregular, and full of hollows, yet no flue has been discovered to connect it with the surface. The floor of the cave consisted of ferruginous unctuous cave earth, extending to a depth of about 7 feet, and intermixed with detached angular fragments of the limestone rock 8 or 9 pounds in weight. On clearing this away it was found to rest on the solid rock, without any trace of sand or shingle.

[1] [The succeeding portion of the paper is compiled from the Author's Note-books.—Ed.]

The fossil remains found in the deposits in 'Long Hole' Cave were transmitted to me for identification by Col. Wood, and are as follows:—

Carnivora.—Ursus spelæus. Putorius vulgaris. Canis lupus. Canis vulpes. Hyæna spelæa. Meles Taxus. Lutra vulgaris. Felis spelæa. Felis catus. Mustela foina ?

Pachydermata.—Rhinoceros hemitœchus. Rhinoceros tichorhinus. Elephas antiquus. Elephas primigenius. Equus Caballus. Equus Asinus. Sus scrofa.

Ruminantia.—Cervus euryceros. Cervus Guettardi. Cervus Tarandus. Cervus Elaphus. Bison priscus.

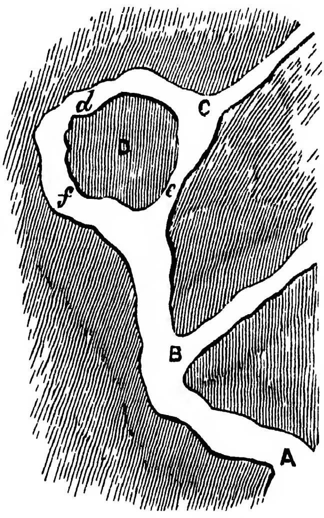
Rodentia.—Lepus cuniculus. Lepus timidus. Arvicola amphibius.

Flint implements, unquestionably of human manufacture, were found along with these fossil remains, and were also sent to me by Col. Wood. One very fine flint arrow-head was found contiguous to, and at the same depth as, a detached shell of a milk molar of *Rhinoceros hemitœchus.* The part of the cave where they were found was about 6 feet from the entrance, and at a depth of 4½ feet in the cave earth. Other flint implements were found at a depth of 3 feet *below* the stalagmite, associated with specimens of *Cervus Guettardi* and the peculiar form of 'Marten,' of which two lower jaws were found in 'Raven's Cliff' (p. 520) *above* the stalagmite. (*Mustela foina ?*)

XX. ON THE FOSSIL REMAINS FOUND IN CEFN CAVE, NEAR BRYN ELWY, N. WALES.[1]

THE cave opens towards the west in a nearly vertical craggy cliff of gray compact limestone which forms the steep eastern boundary of the Valley of the Elwy. The valley runs north and south or NW. and SE. The rock is very fragmented, the cliffs consisting of pieces piled on one another like bricks. There is much yellow cave-earth in the crevices. The cave is at about the middle of the vertical height of the cliff. The opening is something like that of Brixham, but much wider and higher. Near the mouth is a horizontal tunnel-shaped flue, as if hollowed out by sea action. The action of the sea is visible in the cancellar erosion near the mouth. The body of the cavern is formed of a sinuous fissure, which is more capacious and loftier than that of Brixham, being evidently in a line of fault. In the annexed ground-plan (fig. 5), A indicates the opening: B is a 'steep slide' branch, running a considerable way upwards to near the face of the cliff, as shown by fresh roots of trees at the upper part; it does not, however, open into daylight, or if so, the opening is blocked up: C is another similar highly inclined branch rising upwards into daylight with a wide opening; it appears to me to have been the *flue*, through which most of the materials were injected and washed into the cave. Both B and C have their floor covered with very slippery yellow loam. The injecta have been washed down chiefly into *d*, where bones are found. D is an insular irregular cylinder, around

FIG. 5.



GROUND-PLAN OF CEFN CAVE.
Copied from a sketch in Dr. Falconer's Note-book.

[1] Extracted from notes of a visit by the author to Cefn Cave, on August 27, 1859. The fossils were subsequently identified in London.—[ED.]

which the cave passage turns, forming a complete circular communication (*d*, *e*, *f*).

The following is a list of the species which I have identified among the fossils of Cefn Cave :—

Pachydermata.

Elephas antiquus.
Rhinoceros hemitœchus.
,, tichorhinus.
Hippopotamus major.
Equus. Teeth and astragalus. Species undetermined.

Ruminantia.

Strongyloceros spelæus.
Cervus Guettardi.
,, eurycerus.
Bos. Molars of species undetermined.

Carnivora.

Felis spelæa.
Hyæna spelæa.
Ursus spelæus.
Canis lupus.

XXI. ON THE OSSIFEROUS GROTTA DI MACCAGNONE, NEAR PALERMO.[1]

DR. FALCONER first described the physical geography of that portion of the north coast of Sicily in which the ossiferous caves abound, namely between Termini on the east and Trapani on the west. The geological structure of the tract has been ably investigated and mapped by Hoffmann. A great mass of Hippurite-limestone stretches from Termini to the eastern side of the Bay of Castellamare, which on the side towards Termini forms rugged precipitous or scarped cliffs skirting the sea-shore. From Cape Zaffarana to Capo di Gallo, a distance of about twenty miles, the coast-line is deeply indented by the Bay of Palermo; west of Capo di Gallo there is a smaller indentation, backed by Carini; and still further to the west there is the deep Gulf of Castellamare. At the bottom of these indentations the mountains of Hippurite-limestone recede from the coast, forming inland precipitous cliffs or rugged slopes, from the base of which stretch slightly inclined flats of marine Pliocene deposits, which disappear under the sea. These latter form nearly horizontal strata of a calcareo-argillaceous sandy breccia, full of marine shells and fragments of corals, &c. Philippi identified 209 species of Mollusca from this deposit in the neighbourhood of Palermo, the great majority being of living species. The ossiferous caves had been known from remote antiquity, and notices of them occur in Valguarnera, Il Mongitore, and other Sicilian historians. The botanist Cupani had figured and identified some of the bones. The author's investigations had been directed to the caverns near Palermo and Carini. At Palermo the littoral Pliocene plain, celebrated for its richness as the 'Concha d'Oro,' or shell of gold, is from a mile to 1½ mile broad, and where it abuts against the Hippurite-rocks is from 180 to 200 feet above the level of the sea. The ancient Pliocene sea-margin is very distinctly seen at this elevation all round the bay, and the ossiferous caverns chiefly occur at from 30 to 50 feet above this level.

[1] This communication was made by Dr. Falconer to the Geological Society on May 4th and June 22nd, 1859, and is reprinted from the abstract which appeared in the 'Quarterly Journal' of the Society for May, 1860.—[ED.]

Some of them, such as the 'Grotta di Belliemi,' are at a higher level. The caves are studded all round the bay. The Hippurite-limestone hills skirting the coast are here from 1,200 to 1,800 feet above the sea; some of the heights more inland, such as Monte Griffone and Monte Cuccio, attain a height of upwards of 3,000 feet.

The best known of the caves is the 'Grotta di San Ciro,' or 'Mare Dolce,' at the foot of Monte Griffone, about two miles from Palermo, and 50 feet above the Pliocene terrace. This cave had been described by the Abbé Scinà in a special report, and after him by Turnbull-Christie and by Hoffmann. It is about 130 feet long, 50 feet high, and 30 feet wide in the middle. The cave had been hollowed out into a well-marked, irregular, basin-shaped depression near the mouth, where obscurely stratified and other deposits occur to a depth of 30 feet in the aggregate. On the bottom was found a thin layer of sand, in which Philippi detected 44 species of 23 genera of marine Mollusca. Above this there is an enormous mass of bone-breccia, consisting of closely-crammed bones, cemented into a hard rock by an argillaceo-calcareous concrete matrix, and forming a thickness of 20 feet; above this a stratum of stones and bones, more sparingly mixed and similarly cemented, to a depth of 2 or 3 feet; then a layer of 'Lastroni,' or blocks of limestone, to a depth of 6 feet; and above all a layer of ochreous earth and rock-splinters to a depth of 1 foot. The bones in this breccia are mineralized by calcareous infiltration. The interior and back part of the cavern was covered by a layer of light and incoherent argillaceous soil, containing an enormous quantity of bones, chiefly of *Hippopotami*, nearly devoid of gelatine, and in the ordinary friable condition of grave-bones. The relations of this deposit were never accurately observed, in consequence of the rubbish of the excavation-operations having been thrown up in a great mass of talus extending backwards to near the roof of the cavern.

In 1829 there was a great demand for bones for the manufacture of lamp-black for sugar-refining. The superficial bones of the San Ciro cavern were collected in large quantities and exported to England and Marseilles. Professor Ferrara states, that within the first six months 400 quintals were procured from San Ciro. The great majority belonged to two species of *Hippopotamus*. In one heap, out of several shiploads sent to Marseilles, De Christol, an able palæontologist, had found that in a weight of thirty quintals all the bones belonged to *Hippopotamus*, with the exception of six derived from *Bos* and *Cervus*. Dr. Falconer had examined in detail the San Ciro collection in the University of Palermo,

and found, as a general rule, that *Hippopotamus* bones preponderated in a similar proportion. De Christol had counted about 300 astragali alone of this genus; and Abbé Scinà had collected, for the Museum of Palermo, 76 astragali of *Hippopotamus*, 40 of which belonged to the right side and 36 to the left. The bone-breccia is chiefly composed of bones of *Hippopotamus*, and extends on either side outside the cave to a length of about 85 yards. Assuming the above ratio of astragali to the other bones as a standard for an approximative estimate of the number of the skeletons inside and outside the cavern, the author showed what a vast number of individuals it implied. He considered that they were accumulations of a long series of generations. A lively discussion having arisen in Sicily as to the origin of these bones, in which Ferrara maintained the opinion that they consisted of the skeletons of Elephants captured by Metellus from Hasdrubal 504 years before the Christian era, and of *Hippopotami* imported by the Saracen rulers of Sicily during the Middle Ages, the government undertook an exploration of the cavern. A deep trench was dug longitudinally into the cavern; and the bone-breccia was quarried out, along a considerable extent, down to the floor of the cavern. Some very interesting phenomena were disclosed. The eastern wall (left, on entering) was found to be smoothly polished to a height of 18 feet, the lower 8 feet of which formed a band thickly drilled with Pholad-borings. The holes were filled with matrix of the bone-breccia, and they were greatly reduced in depth by the grinding action which had produced the polished surface. The opposite wall of the cavern was equally polished to the same height, but free from borings.

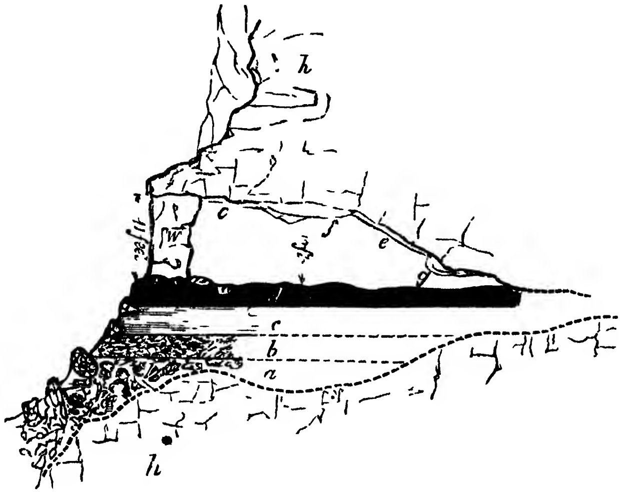
The walls above the polished band and the roof were rugged and cancellar, with but a very sparing exhibition of stalagmite on the latter. The author had identified from San Ciro two species of *Hippopotamus*,[1] *Elephas antiquus*, *Sus*, *Bos*, *Cervus*, *Ursus*, *Canis*, and a large species of *Felis*. *Elephas antiquus* elsewhere indicates the newer Pliocene age.

Another cave, hitherto undescribed, called the 'Grotta di Maccagnone,' about a mile to the westward of Carini, was lately the special subject of the author's research. It is nowhere noticed by the Sicilian historians. Dr. Falconer's attention had been directed in that quarter by J. Morrison, Esq., a resident merchant of Palermo, who had many years ago procured fossil bones from the neighbourhood of Carini,

[1] *Extract from Author's Note-book.*—'Naples, Jan. 29, 1859. The Hippopotamus bones from Sicily are of two species, the great majority being of *H. Pentlandi*, but the large inferior canine is certainly of another species, and apparently of *H. major*.'—[Ed.]

which are now displayed in the Museum of the College of Surgeons. The author was under great obligations to the kind services, scientific aid, and hospitable cares of Baron Francesco Anca (di Mangalaviti) and Professor Angelo Porcari, of the University of Palermo, who accompanied him in all his visits to Carini, and co-operated with him in the excavations carried on in and near the Maccagnone Cave. Their assistance applied to every walk of the exploration. The cave is situated on the north-eastern side of Monte Lungo, near its base, and about a mile and a half from the sea. Like San Ciro, the Maccagnone Cave is about 50 feet above the termination of the Pliocene marine terrace where it abuts against the Hippurite limestone, and at a corresponding elevation above the sea; both caves partaking in many respects of common physical characters. But in its form, and some of its deposits, the Maccagnone Cavern differs materially from San Ciro. It is much broader and more sinuous at the sides than San Ciro, with several large *cul-de-sac* expansions, but not so long; and the roof is much lower, being but 11 feet high at the principal entrance, and about 10 feet in the middle. There are two entrances, the principal of which is 25½ feet wide, and open down to the floor; the other, on the same side of the hill, is a much smaller, irregular aperture, in connection with an irregular expansion of the cavern at its south-eastern corner, into which it descends. The author gave the principal dimensions, which were accompanied by a section and ground-plan (figs. 6 and 7). The uppermost layer of the floor consists throughout of loose, argillaceous, finely pulverized soil, containing large embedded blocks of limestone; beneath this, in the section below the mouth, was a thick deposit of the ochreous loamy earth (called 'Cave-earth'), containing blocks of limestone; then, in thick patches, a reddish-grey and mottled spongy loam, cemented by calcareous infiltration, and very cellular, called from its appearance, by the peasants who were employed in the excavation, '*Ceneri impastate*,' or 'concrete of ashes;' and below all, stretching on either side of the mouth, as at San Ciro, a great aggregation of bone-breccia, full of bones of *Hippopotamus*, among which the author in four days collected a very large number of astragali. The whole of the bone-breccia was strewed over with huge blocks of limestone which had fallen since its deposition. Nothing is known of the nature of the inferior deposits down to the floor. The author thinks it probable that there may be a great accumulation of bone-breccia below, with polished and bored walls, as in San Ciro; but the excavations requisite to establish this were too laborious and extensive for the limited time at

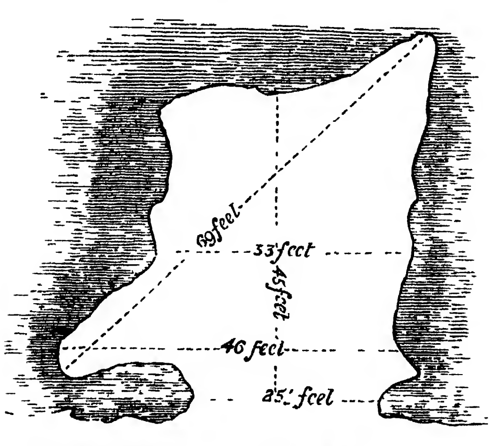
Fig. 6.



VERTICAL SECTION OF THE GROTTA DI MACCAGNONE.

a. Bone-breccia, with blocks of limestone.
b. Grey cancellar deposit.
c. Yellow ochreous bed, or 'cave-earth,' with blocks.
d. Humatile layer, with blocks of limestone.
e. Stalagmite coating the ceiling of the cave.
f. Roof-breccia cemented to the ceiling.
g. Roof-breccia in the back of the cavern, coated with stalagmite.
h. Hippurite limestone.
w. Wall of the entrance.

Fig. 7.



GROUND-PLAN OF THE GROTTA DI MACCAGNONE.

his disposal. The interior of the cavern is coated over throughout by a crust of rough, reddish or ochreous stalagmite. The surface-layer of the floor had been previously dug for fossil bones as far back as 1830, and but few remains were found in it. One—an important specimen—was a milk molar of *Elephas antiquus*. At the side below the southern wall of the cavern, and about halfway in, a thick layer was observed of the 'Ceneri impastate' immediately below the superficial earth, and corresponding exactly with the 'Ceneri impastate' seen in the section outside below the principal aperture. The attempts at making a section of the floor were frustrated by the great blocks of limestone, which impeded the operations throughout. In the superficial layer, *Elephas antiquus* and horns of two extinct species of *Cervus* were found, besides other bones of Ruminants, but all in small quantity: in the ochreous cave-earth below the mouth, abundant coprolites of *Hyæna*, with fragments of detached bones of *Hippopotamus*, and some astragali: in the 'Ceneri impastate' below the main aperture, metacarpal and metatarsal bones of a species of *Felis* as large as *F. spelæa*, but not yet specifically identified; some remains of a large *Ursus*,[1] and numerous remains of small Ruminants, all broken or splintered, but none of them bearing marks of gnawing. In the 'bone-breccia' below and outside the cavern, the bones of *Hippopotami* very largely predominated. The author dug up an enormous quantity of these remains within an area of 12 or 14 feet square. In an angular recess in the rock outside the cave, and near the small opening, a very large quantity of coprolites of Hyænas were observed, superficially embedded in the 'ochreous earth.' The quantity collected together would indicate that this spot had been used as a common cloaca of Hyænas.

The author next described some remarkable conditions in the roof of the cave. About halfway in from the mouth (fig. 6, *f*) and at 10 feet above the floor, a large mass of breccia was observed, denuded partly of the stalagmitic covering, and composed of a reddish-grey argillaceous matrix cemented by a calcareous paste, containing fragments of limestone, finely preserved entire land-shells of large size, splinters of bone, teeth of Ruminants and of the genus *Equus*, together with comminuted fragments of shells, bits of carbon, specks of argillaceous matter resembling burnt clay, also fragments of shaped siliceous objects, of different tints, vary-

[1] The specimens of *Ursus* from Maccagnone were found to agree with those from Grays Thurrock in the British Museum, purchased from Mr. Ball, and were believed by Dr. Falconer to be of the same species. (Note-book.)—[ED.]

ing from the milky or smoky colour of chalcedony to that of jaspery hornstone. This brecciated matrix was firmly attached to the roof, and for the most part covered over with a coat of stalagmite. In the SSE. expansion of the cavern near the small aperture, a considerable quantity of coprolites of *Hyæna* was found similarly situated, in an ochreo-calcareous matrix, adhering to the roof, mingled with some bits of carbon, but without shells or bone-splinters. In the back part of the cavern, where the roof shelves towards the floor, thick masses of reddish calcareous matrix were found attached to the roof, and completely covered over by a crust of ochreous stalagmite (fig. 6, *g*). It contained numerous fragments of the siliceous objects mixed with bone-splinters and bits of carbon. In fact, all round the cavern, wherever the stalagmitic crust on the roof was broken through, more or less of the same appearances were presented. In some parts the matrix closely resembled the character of the 'Ceneri impastate' with a larger admixture of calcareous paste.

With regard to the fragments of the siliceous objects, the great majority of them present definite forms, being long, narrow, and thin; having invariably a conchoidal smooth surface below, and above a longitudinal ridge, bevelled off right and left, or the ridge replaced by a concave facet, in the latter case presenting three facets on the upper side. The author is of opinion that they closely resemble, in every detail of form, obsidian knives from Mexico, and flint knives from Stonehenge, Arabia, and elsewhere, and that they appear to have been formed by the dislamination, as films, of the long angles of prismatic blocks of stone. These fragments occur, intimately intermixed with the bone-splinters, shells, &c., in the roof-breccia, in very considerable abundance; other amorphous fragments of flint are comparatively rare, and no pebbles or blocks occur either within or without the cave; but similar reddish flint or chert is found in the Hippurite-limestone near Termini.

In regard to the theory of the various conditions observed in the Maccagnone Cave, the author considers that it has undergone several changes of level, and that the accumulation of bone-breccia below and outside is referable to a period when the cave was scarcely above the level of the sea. Dr. Falconer pointed out the significance of the fact that, although Hyæna-coprolites were so abundant against the roof and outside, none, or but very few, of the bones of Hyænas were observed in the interior; he remarked also on the absence of the remains of small mammalia, such as Rodents. He inferred that the cave in its present form, and with its present floor, had not been tenanted by these animals.

The vast number of *Hippopotami* implied that the physical condition of the country must have been greatly different, at no very distant geological period, from what obtains now. He considered that all deposits *above* the bone-breccia had been accumulated up to the roof by materials washed in from above, through sinuous crevices or flues in the limestone, and that the uppermost layer, consisting of the breccia of shells, bone-splinters, siliceous objects, burnt clay, bits of charcoal, and Hyæna-coprolites, had been cemented to the roof by stalagmitic infiltration. The entire condition of the large fragile *Helices* proved that the effect had been produced by the tranquil agency of water, as distinct from any tumultuous action. There was nothing to indicate that the different objects in the *roof-breccia were other than of contemporaneous origin*; subsequently a great physical alteration in the contour, altering the flow of superficial water and of the subterranean springs, changed all the conditions previously existing, and emptied out the whole of the loose incoherent contents, leaving only the portions agglutinated to the roof. The wreck of these ejecta was visible in the patches of 'Ceneri impastate,' containing fossil bones, below the mouth of the cavern. That a long period must have operated in the extinction of the Hyæna, Cave Lion, and other fossil species, is certain; but no index remains for its measurement. The author would call the careful attention of cautious

List of Fossil Shells found in the 'Grotta di Maccagnone,' as determined by Padre Lebassi, Curator of the Museum of the 'Collegio Massimo dei Gesuiti' in Palermo, March 18, 1859.

	Where found	Remarks	Remarks by Padre Lebassi
1. Helix Mazulii. . .	Roof matrix, back part of cave.	A solitary shell, partly broken.	Very rare in Sicily in the fossil state.
2. Helix aperta (Born.) (H. naticoides, Drap.)	Roof-matrix.	—	Very abundant in the living state: like *H. Mazulii.*
3. Helix vermiculata . .	Roof-matrix	Very abundant: shells in perfect integrity.	Very common in the living state: rare fossil.
4. Helix cellaria (Müller)	Roof-matrix.	—	Very common in living state: not observed fossil by Philippi.
5. Trochus fragaroides (Lam.)	—	—	Very common: living.
6. Patella ferruginea (Linn.)	—	A solitary specimen.	Very rare in the sea around Sicily: very common fossil.

geologists to the inferences :—1. That the Maccagnone Cave was filled up to the roof within the human period, so that a thick layer of bone-splinters, teeth, land-shells, Hyænas' coprolites, and human objects was agglutinated to the roof by the infiltration of water holding lime in solution. 2. That subsequently, and within the human period, such a great amount of change took place in the physical configuration of the district as to have caused the cave to be washed out and emptied of its contents, excepting the patches of material cemented to the roof and since coated with additional stalagmite.

Note.—The author has lately received a letter from Baron Anca di Mangalaviti, dated Palermo, the 12th of March, intimating that he had followed up the Cave-researches which form the subject of this communication, with important results. He had discovered two caves, hitherto unknown to naturalists—the one in Monte Gallo, which forms the western boundary of the Bay of Palermo; the other in the north of Sicily, at the foot of Monte San Fratello, near the village of Acque Dolci. In both caverns, but more especially in the latter, Baron Anca found an immense accumulation of fossil bones, among which there was 'une prodigieuse quantité d'os des Carnivores.' This is the more remarkable, as in the Caves of San Ciro and Maccagnone Carnivora were but very sparingly encountered.—H. F., *April* 5, 1860.

APPENDIX TO MEMOIR ON THE GROTTA DI MACCAGNONE.

I.—Notice of the Discovery of Two Bone-Caves in Northern Sicily. By François Anca, Baron de Mangalaviti.[1]

Since you left Sicily, I have continued my palæontological researches, and I am happy in having discovered two bone-caves previously unknown. One of these is at Monte Gallo, at the western extremity of the Bay of Palermo, and is situated at an elevation of 160 feet above the sea-level; the other is situated near the village of Acque Dolci, at the foot of Monte San Fratello, in the north of Sicily, and is 214 feet above the sea-level.

These caves, especially the last, are very rich; and, what will astonish you, they contain a prodigious quantity of bones of *Carnivora*, including perfect jaws armed with molars and canines. I have collected also two molars and a tusk of *Elephas*, teeth and bones of *Hippopotamus* (of the two species, I believe, determined by yourself). Altogether, remains of the following were met with :—

[1] From a letter to Dr. Falconer, dated 'Palermo, March 12, 1860,' and published in the 'Quart. Journ. Geol. Soc.' for May, 1860.—[Ed.]

Hippopotamus; two species.
Elephas antiquus.[1]
„ Africanus.[2]
Sus scrofa?
Equus.
Bos; two species.
Cervus (two species?).
Canis.
Ursus.
Hyæna.
Felis.
Lepus. And others.

Having this large group of genera, we may say that we have recovered in this cave an entire fossil Sicilian Fauna.

I have also found in these two caves a large quantity of flint implements ('de silex en armes'); and it is remarkable that we do not generally see them but where there are great deposits of bones of Deer—never otherwise. Lastly there occur coprolites of Carnivores, and another kind of coprolite, which, I suppose, belonged to herbivorous animals.

I have been fortunate also in detecting teeth of Carnivora in the Cave of Olivella ('la grotte de l'Olivella').

The necessity of having means of comparison at hand induces me to prosecute the study of these cave-bones at Florence, where I shall have the assistance of M. Meneghini. Afterwards I hope to publish the results of the exploration of these caves, and to describe them and the more interesting of the objects obtained.

II.—Extract of a Letter from Dr. Falconer to Capt. Spratt, C.B.

Dated July 21, 1860.

A Sicilian friend of mine, Barone Francesco Anca, who accompanied me in my cave explorations, followed them up after I left, and in the cave of San Teodoro, near S. Agata, west of Cape Orlando, on the north coast, he discovered molar teeth, which prove to be of the existing African Elephant,[3] and about twenty jaws, upper and lower, of the *Hyæna crocuta*, or spotted Hyæna of the Cape of Good Hope.[4] Here, then, we have two existing African mammalia occurring in Sicily, and proving beyond all question that Sicily within the Pleistocene period was connected by land with Africa. The severance of the island from the continent must have been quite as modern an event as the separation of England from France. The continuity of the land evidently lay in Admiral Smyth's 'Adventure Bank' and 'Skerki Shoal.' Smyth's section of the bank shows how very shallow the soundings are. There must have been continuous land from Ras Addar (Capo Bono) through Sicily on as far as Messina, with a distinct eastern and western basin. It now becomes of great interest to ascertain whether the Strait of Messina was then an open channel, or closed up by land like 'Adventure Bank.' A great many complex problems are involved in the case. You know what countless Hippopotami have been met with in Sicily—literally tens of thousands, of two species. Your remains from the Krendi Cave are identical with one of the Sicilian species, and it is clear

[1] The statement at page 250 of the paper on *E. Columbi*, written two years after the publication of this letter, renders it doubtful if this was really *E. antiquus*.—[Ed.]

[2] See *antea*, p. 283.—[Ed.]

[3] *Extract from Letter to M. Lartet, Nov.* 1, 1864.—'The San Teodoro specimens are certainly of the African Elephant.'—[Ed.]

[4] See *antea*, p. 465.—[Ed.]

that Malta and Sicily must have been continuous. But a great *fresh-water* Mediterranean lake hypothesis will not apply to the case. There are no freshwater deposits on the north coast of Sicily, but abundance of marine Pliocene strata. Further, the Hippopotamus remains from Candia are the same as the Sicilian. Candia must at that time have been connected with the Morea.[1]

[1] If Dr. Falconer had lived, he contemplated writing an essay 'On the Proofs of the Severance of Sicily from the Continent of Africa, within the modern period.' See also p. 596.—[Ed.]

XXII. ON THE FOSSIL CONTENTS OF THE GENISTA CAVE, GIBRALTAR.

BY HUGH FALCONER, M.D., V.P R.S., FOR. SEC. G.S., AND G. BUSK, ESQ., F.R.S., F.G.S.

[In a Letter to His Excellency General Sir W. J. Codrington, K.C.B., &c. &c. Governor of Gibraltar.][1]

THE circumstances which led to our visit to Gibraltar, and the objects we have had in view, are so well known to your Excellency that it is unnecessary on our part to do more than refer to one or two incidents in the early history of the cave.

When the interesting objects contained in the upper chambers of the 'Genista Cave' on Windmill Hill were brought to light by Capt. Brome, your Excellency addressed a letter to the Secretary-at-War, giving a preliminary report on the results; that communication was forwarded from the War Office to the President of the Geological Society of London, with a request for an opinion as to the importance in the interest of science of following up the exploration, and for suggestions as to the manner in which it could be best conducted. The reply led to the sanction of the Secretary-at-War for the further exploration of the cavern by means of the labour of the military prisoners, under the able superintendence of Capt. Brome; and, to pass over minor incidents well known to your Excellency, the objects discovered were forwarded to us in London for identification and scientific examination.

Having devoted several months to the study of the cave-collections successively transmitted to us, which were so carefully classified, by means of distinctive marks, by Capt. Brome, the Governor of the Military Prison, as to place the main facts clearly before us, we were so strongly impressed with their importance that we determined, on your Excel-

[1] This letter, written at Gibraltar in October 1864, was communicated by the Secretary of State for War to the Geological Society after Dr. Falconer's death, and was published in the 'Quarterly Journal of the Geological Society,' for March 1865. In September 1864, the British Association placed 150*l.* at the disposal of Dr. Falconer and Mr. Busk, for the purpose of promoting researches in the ossiferous caves of Gibraltar, and up to the time of his death Dr. Falconer was busily engaged in identifying the fossils which were sent home.—[ED.]

lency's invitation, to visit Gibraltar and examine the general condition of the cave on the spot; for the discoveries in the Windmill Hill Cave have not only yielded unexpected results regarding the former state and the ancient animal population of the rock itself, but they further point to a land connection between the southern part of the Iberian peninsula and the African continent at no very remote geological epoch.

Capt. Brome's Report, dated 21st August, 1863, with the plan and section which accompany it, so clearly explains the nature of the Windmill Hill Cave, that it is unnecessary for us to enter on the present occasion into any detailed description of it. The rock abounds in caves, which are of two classes. 1st. Seaboard caves at various heights above the level of the sea and horizontally excavated in the ancient cliffs by the waves. 2nd. Inland caves descending from the surface and in connection with great vertical fissures, by which the mass of the rock has been rent at remote epochs during disturbances caused by violent acts of upheavement, like the well-known cavern of St. Michael. The 'Genista' Cave of Windmill Hill belongs to the second class; it forms part of a great perpendicular fissure, which, by the vigorous measures adopted by Capt. Brome, has either been excavated or traced downwards to a depth of upwards of 200 feet below the level of the plateau of Windmill Hill. It was full of the fossil remains of quadrupeds and birds, of the former of which some are now wholly extinct, others extinct in Europe and repelled to distant regions of the African continent, others either now living on the rock or in the adjoining Spanish peninsula.

The following is a list of the species which we have at present identified :—

Pachydermata.

Rhinoceros Etruscus (?).[1] Extinct.

Rhinoceros leptorhinus (*syn.* R. megarhinus). Extinct; abundant.

Equus. Young animals only; species undetermined.

Sus priscus (?). Extinct.

Sus scrofa. Living.

Ruminants.

Cervus Elaphus, *var.* barbarus. Fossil remains abundant.

Cervus Dama, or a nearly allied form. Abundant.

[1] In the Gibraltar cave we have got an upper half of a femur of a Rhinoceros which is small, old, and indistinguishable in size and form from *R. Etruscus*, but no teeth as yet. All the other specimens — teeth, tibias, astragalus, atlas, &c., belong to *R. leptorhinus* (*R. megarhinus*).—*Letter from Dr. Falconer to M. Lartet, Sept.* 9, 1864.—[Ed.]

Bos. A large form, equalling the Aurochs in size; remains few and imperfect; species undetermined.

Bos taurus. Abundant in the upper chamber.

Capra hircus (?). In the upper chamber.

Capra Ægoceros, form A.; Capra Ægoceros, form B. Two forms of *Ibex*, probably extinct, but in vast abundance throughout the fissure.[1]

Rodents.

Lepus timidus. Rare.

Lepus cuniculus. Very abundant at all depths.

Mus rattus.

Carnivora.

Felis Leopardus.

Felis pardina.

Felis serval.

Hyæna brunnea.[2]

Canis vulpes.

Ursus, *sp.* Not the Cave Bear; form undetermined.

Delphinidæ.

Phocæna communis.

Birds. Remains numerous; genera and species undetermined.

Tortoise. Rare; species undetermined.

Fish. Remains numerous in the upper chamber.

[1] *Extract of Letters from Dr. Falconer to M Lartet, Sept.* 9, 1864.—'I am of opinion that there are two distinct species of Ibex among the Gibraltar fossils; the one large with a step to the last lower, and a grooved flange to the talons of the last upper, molar. We have a beautiful upper maxillary of this form which you have not seen. It is larger than a very large male Siberian Ibex. The following are the dimensions of the 6 molars:—

	Upper maxilla In.	Lower maxilla In.
Small Gibraltar Ibex	2·85	
Large „ „	3·25	
Siberian Ibex . . .	2·85	2·82
Pyrenean Ibex, female	2·8	2·95
Nubian Ibex, male ·	2·8	2·97

'The larger upper maxillary of Gibraltar has the teeth quite as large in proportion as your large lower jaw from the "Gorge d'Enfer." In my view the latter agrees with the characters of the Ibex of the Alps, and differs from the Siberian or Nubian forms. We have no jaw so large.' *Sept.* 11, 1864.—'Our large upper maxillary of Gibraltar Ibex compares well with the Ibex of the Alps (female). From another cave in Gibraltar (the Judge's Cave) we have the lower jaw of an Ibex, entire to the tip of the coronoid, which is nearly of the same age as your "Gorge d'Enfer" specimen.

	Gorge d'Enfer In.	Gibraltar (B) In.
Height of four last molars	2·7	2·45
Height of jaw at penultimate . .	1·7	1·15

'The lower jaw of the female Ibex of the Alps has the penultimate and last lower molars very much as in the Gibraltar form (B) and as in the "Gorge d'Enfer" specimens, but the horn-core is nearly round in section and less abruptly acuminated, and there is no lateral compression.'—[Ed.]

[2] *Hyæna crocuta.* See *antea*, p. 465, *note* 2, and Mr. Busk's paper in the Proc. Lin. Soc. for May 3, 1866, p. 62.—[Ed.]

Apart from the still immature state of the investigations, it would be quite beyond the limits within which we are restricted in this communication for us to enter in detail upon the conclusions to which the data furnished by the fossil remains lead; we shall therefore confine ourselves to a few of the more important general points.

The rock is now bared of natural forest-trees, and destitute of wild animals, with the exception of the hare, rabbit, fox, badger, and a few magot monkeys, the last in all probability the descendants of introduced animals. The fossil remains of the 'Genista Cave' establish beyond question that the rock was formerly either peopled by, or the occasional resort of, large quadrupeds like the elephant, rhinoceros, aurochs, deer, ibex, wild horse, boar, &c., which were preyed upon by hyænas, leopards, the African lynx, and serval: that the remains were transported by any violent diluvial agency from a distance is opposed to all the evidence of the case. The manner in which they were introduced into the Windmill Hill Cave we believe to have been thus:—The surface of the rock and its level in relation to the sea were formerly different from what we now see. The wild animals above enumerated, during a long series of ages, lived and died upon the rock. Their bones lay scattered about the surface, and in the vast majority of instances crumbled into dust, and disappeared under the influence of exposure to the sun and other atmospheric agencies, as constantly happens under similar circumstances at the present day. But a certain proportion of them were strewed in hollows along the lines of natural drainage when heavy rains fell; the latter, for the time converted into torrents, swept the bones, with mud, shells, and other surface-materials, into the fissures that intercepted their course; there the extraneous objects were arrested by the irregularities of the passages, and subsequently solidified into a conglomerate mass by long-continued calcareous infiltration. That elephants frequented the rock is proved by a valuable and perfect specimen of the penultimate upper molar tooth of an extinct species, which we have ascertained to be *Elephas antiquus* discovered by Mr. Smith of Jordan Hill, in a sea-beach on Europa Point, 70 feet above the level of the sea. That the hyænas were dwellers upon the rock is also established by the fact that, in addition to numerous bones, we have discovered a considerable quantity of *coprolites* of *Hyæna brunnea*[1] among the 'Genista Cave' relics. Some of the species must have peopled the rock in vast numbers. We infer, upon a rough estimate, that we have passed through our hands bones derived from at least two or three hundred

[1] See *antea*, p. 556, *note* 2.—[Ed.]

individuals of Ibex swept into the Windmill Hill fissure; in no instance have we observed fossil bones attributable to one complete skeleton of any one of the larger mammalia.

That the rock now so denuded of arboreal vegetation was then partially clothed with trees and shrubs, as the corresponding limestone mountains on the opposite side of the straits are at present, is so legitimate an inference as hardly to be open to rational doubt. It is now a pinch to find sufficient food at the end of the hot season for the flocks of goats which are reared on the promontory; while it is a matter of absolute difficulty to find fodder at all for the few cows that are kept by some of the officers of the garrison. When elephants, rhinoceros, wild oxen, horse, boar, deer, &c., &c. either peopled or resorted to the rock in considerable numbers, there must have been abundant trees and more or less constant green food for them. Bare exposed masses of rock get intensely heated by a southern sun, they repel moisture by being thus heated, and raise the mean temperature of the locality by radiation; while, on the contrary, a clothing of trees and of fruticose vegetation both tempers the heat, attracts moisture, and greatly increases the fall of rain. We are aware that your Excellency's attention has been directed to planting-operations on the 'rock.' Numerous and repeated failures must be looked for at the commencement; but the facts above mentioned would indicate that success may ultimately be attained, with much benefit to the station.

The next prominent point in the case is the character of the extinct fauna of Gibraltar regarded as a group. Of the prevailing fossil forms which occur in England, Germany, and France, as far south as the northern slope of the Pyrenees and the shores of the Mediterranean, such as the Mammoth, *Rhinoceros tichorhinus*, *Ursus spelæus*, *Hyæna spelæa*, &c.,[1] not a vestige has been detected among the fossil remains of Gibraltar. In the latter the Carnivora are the most significant. The three species of *Felis* are of African affinities; and *Hyæna brunnea*,[2] now for the first time ascertained to have existed formerly in Europe, is at the present day chiefly found near the Cape of Good Hope and Natal. That any of these wild animals could have crossed the straits from Barbary to Europe is contrary to all probability. The obvious inference is that there was a connection by land,[3] either circuitous or

[1] *Letter to M. Lartet, Sept.* 29, 1864. 'We found not a trace of *Cervus Tarandus*, or of the *Lagomys* figured by Cuvier.'—[Ed.]

[2] This identification has since been shown to be an error.—See *antea*, p. 556, *note* 2.—[Ed.]

[3] See *antea*, pp. 552–3.—[Ed.]

direct, between the two continents, at no very remote period, somewhere within the Mediterranean area. To arrive at any further evidence bearing upon this very important question, from the rock of Gibraltar, becomes an object of the highest general and scientific interest.

Human remains were found in great abundance in the upper chambers. They appear to have belonged to between thirty and forty individuals. They were accompanied by stone implements of the polished-stone period, broken querns, a large quantity of pottery, marine shells of edible species, and some other objects enumerated in Capt. Brome's Report. No way of access from the surface by which these materials could have been introduced has been discovered; but, on carefully examining the ground, we believe, with Capt. Brome, that the entrance was somewhere under the southern half of the east wall of the prison-enclosure. Until the aperture from the surface is discovered, no certain conclusion can be arrived at. Considering the time and labour which have been expended on the cavern, it would be a subject of great regret if the exploration were left incomplete on this important point. We would therefore venture strongly to recommend that the excavations be continued through the ground over which the east wall runs, until the external aperture is detected. We believe that it will be found in the fissure outside the east wall, which Capt. Brome has so sagaciously and perseveringly explored.

The human bones are of high interest in consequence of certain peculiar characters which many of them present. They appear to belong to widely different epochs, although none of them perhaps of very high antiquity (*i.e.* before the historical period). That the upper chambers of the cave were ever inhabited by savage man we consider to be highly improbable. It seems more likely that they were used as places of deposit for the dead.

As regards the final disposal of the interesting and important relics discovered in the 'Genista' Cave, a complete series ought to be deposited in London, either in the British Museum or in the Museum of the Royal College of Surgeons. But we consider it to be of still higher importance that a collection should be retained for Gibraltar. In the progress of the vast defensive works which have been carried on during the past century, in scarping and tunnelling the rock, objects of high interest, relating either to its natural history or archæology, have been brought to light; but in the great majority of cases they have either been disregarded or lost. Instances might be cited from Col. James's 'History of the Herculean Straits,' 1771, and from Major Imrie's 'Memoir on the

Mineralogy of the Rock,' in 1797. In 1844 a laudable effort was made by the late Archdeacon Burrow to establish a museum on the rock; but, after languishing some time, it failed from the want of proper support. The relics of the collection were afterwards exhibited in the Soldiers' Home; but when that institution was given up, no place remained either for displaying or taking proper care of the collection. Some of the brightest records of the military glory and prowess of our country are indissolubly connected with Gibraltar. A great nation like England cannot afford to neglect, or disregard without reproach, whatever bears on the natural history or archæology of so renowned a possession. That the naval and military services take the liveliest interest in such objects is placed beyond doubt by the United Service Museum of London, founded upon collections contributed by them from all parts of the world; but it appears to us that the formation and maintenance of a local museum at Gibraltar, illustrative of its products and relics, ought not to fall upon the garrison, who are only temporary residents, and that it is more properly an Imperial obligation. The least expensive and best mode of carrying the object into effect would probably be to have a room in the Library reserved for the purpose, and under the management of the Library Committee. The only outlay would be in the construction of the apartment and in the glass cases for the objects; no establishment would be required.

In case of any proposal of this nature being entertained, we would venture to suggest to your Excellency that the collection should be strictly limited to objects of local interest, having reference to the rock, the bay, the straits, and the immediate vicinity. Everything from beyond these limits should be excluded. A museum of reference of this nature should include:—

1. Herbarium collection of the plants yielded by the rock.
2. A zoological collection of all objects, terrestrial and marine, produced within the limits.
3. A collection of specimens of minerals of the rock.
4. A complete collection of the fossil remains yielded by the ossiferous caves and bone-breccia of Gibraltar.
5. An archæological collection of coins, pottery, and other antique relics occurring within the circuit of the bay.

In illustration of the absolute need there is of a local collection of the kind here indicated, we may mention that, being anxious to fix the age of the pottery yielded in such abundance by the Windmill Hill Cave, no similar materials for comparison derived from the ancient ruins of Carteia, or

from points in the Mediterranean resorted to by the Phœnicians, were to be found in the British Museum.[1] The proof of the antiquity of the human race is one of the leading questions that occupy the attention of educated and scientific men at the present day. That human remains and other objects bearing upon it are considered of high value is sufficiently proved by the fact that a grant of 1000*l.* was passed for the purchase of a collection of this kind from the Valley of the Vézère, in the south of France, during the last session of Parliament, for the British Museum. One of the human skulls yielded by the rocks many years since appears to us to point to a time of very high antiquity. In fact, it is the most remarkable and perfect example of its kind now extant.[2] In the absence of a properly organized museum no record exists of the precise circumstances under which this interesting relic was found, and that it has been preserved at all may be considered a happy accident; it has cost us much labour, and with but partial success, to endeavour to trace its history on the spot where it turned up.

Our time has been so fully occupied by the examination of the cave collections and collateral subjects that we have only been able to make a cursory examination of the geology of the rock. We entirely agree with the opinions expressed in the excellent memoir of Mr. James Smith, of Jordan Hill, that it bears unmistakeable evidence of having undergone extraordinary disturbance, both of upheaval and depression, during the Quaternary or immediately pre-modern period; but the data are complex, and in some instances obscure. Now that a complete topographical survey of the rock has been completed on a large scale, a geological survey would be a matter of comparative ease; and we would submit to your Excellency's consideration the expediency of an application being made for the services of an assistant upon the Geological Survey of England, to be deputed for the purpose. The area is so compact and limited that the survey, including that of the surrounding bay, need not occupy much time.

We cannot bring this letter to a close without expressing our opinion of the value and importance of Capt. Brome's

[1] *Extract of Letter from Dr. Falconer to M. le Duc de Blacas.*—'Of the pottery, several rude vases are quite entire. None of them in the slightest degree resembles the 'Hut Vase' to which you refer, but rather some of the small vases, cups, &c., which surround the Hut Vase figured by Visconti (Pl. i.), or as figured in "Birch's Ancient Pottery," vol. ii. p. 197, fig. 175.'

[2] Respecting this skull, Dr. Falconer wrote to a relative as follows: 'If you hear any remarks made, you may say from me, that I do not regard this *prisсan pithecoid man* as the "missing link," so to speak. It is a case of a very low type of humanity—very low and savage, and of extreme antiquity—but still man, and not a halfway step between man and monkey.'—[Ed.]

exploration of the Windmill Hill Cavern, under the support and enlightened countenance and encouragement which we are well aware he has uniformly received from your Excellency during the progress of his operations, and which have led in a great measure to their successful issue. The only account of the mineralogy of Gibraltar that has been published is in the excellent 'Brief Description' by Major Imrie, of the Royal Artillery, which appeared in the 'Edinburgh Philosophical Transactions' in 1797. In 1844 Mr. Smith, of Jordan Hill, brought out his valuable memoir on the Geology of Gibraltar; but the fossil mammalian remains of the bone-breccia were only very cursorily noticed by both authors. In the latter half of the last century they attracted the attention of William and John Hunter, in papers which are to be found in the 'Royal Transactions,' but without an attempt at precise identification. Cuvier, in his great work, the 'Ossemens Fossiles,' in 1823, gave a special chapter on the ossiferous breccias, and devoted much attention to those of the Mediterranean. From the materials derived from the rock which passed under his hands, he was able to detect evidence only of two extinct species, one of which is doubtful. He concludes his remarks on the Gibraltar remains in the following terms:—

'Voilà donc dans ce petit nombre d'os de Gibraltar que j'ai pu me procurer, au moins une espèce de lièvre et probablement une espèce de cerf, dont les pareils ne sont pas connus en Europe.

'Que seroit-ce si quelque naturaliste résidant sur les lieux prenoit la peine de recueillir et de dégager avec soin ceux qui se découvriroient pendant quelques années, comme je l'ai fait pour les ossemens de nos gypses? D'après ce que nous allons voir dans les articles suivans, on ne peut douter qu'il n'y fît des récoltes abondantes et intéressantes.' (*Op. cit.* tome iv. p. 174.)

From that period down to the present day hardly any addition has been made to our knowledge of the subject, during a lapse of forty years, until Capt. Brome undertook the exploration of the 'Genista Cave;' and the best commentary upon the preceding citation is furnished by the fact that the materials collected by him have enabled us to determine upwards of twenty species of mammalia above enumerated, many of them extinct, and all of them bearing importantly on the ancient condition of Gibraltar. Indeed it is within the facts of the case to say that, in the important walk of the mammalian palæontology of Gibraltar, Capt. Brome has done more than was effected by the united labours of his predecessors since the rock became a British possession. The per-

severing energy and vigour with which he has followed up the inquiry, and the minute and scrupulous care with which he has discriminated and arranged the objects, are worthy of the highest commendation, and more especially so as the subject was new to him. We are inclined to believe that the labour of military prisoners was never better directed in the interest of science.

We have to tender our best acknowledgments to your Excellency for the very cordial reception which you have given us, and for the pains you have taken to forward the objects of our visit in every respect. We beg leave also, through your Excellency, to offer our thanks to the military, naval, and civil departments of the service for their hearty co-operation. Our thanks are more especially due to Major-General Frome and the officers of the Royal Engineers, and to Capt. Ommanney, R.N., the senior naval officer of the station, who have rendered us every assistance.

XXIII. NOTES ON A COLLECTION OF FOSSIL BONES DISCOVERED IN A SECTION OF GRAVEL IN EXCAVATING THE FOLKESTONE BATTERY.[1]

THE fossil remains to be noticed in the sequel were disclosed during the excavation of the Folkestone Battery. A careful section of the ground was made by Lieut. Robert Vetch of the Royal Engineers, consisting first of the lower greensand and blocks of Kentish rag to a depth of 10 ft. 8 in.: next, in ascending order, a bed of marl and flint gravel, which immediately caps the lower greensand, and in which alone the fossil bones were found; this bed was 18 in. thick: next, a whitish loam, varying from 4 ft. 6 in. to 7 ft. 6 in., which is used as a brick-earth: and above all was a superficial layer of made earth 6 in. deep. At the bottom of the section abundant remains of Perna and ——[2] were found, these being characteristic greensand fossils. The collection of fossil bones is of great interest from the unusual association of old and glacial forms of Mammalia which it discloses, including *Hippopotamus major* and the Irish Elk (*Cervus euryceros*), with remains of Rhinoceros and other forms. They are all in precisely the same mineral condition, and some of the largest bones are in a state of such perfect integrity that it is clear they cannot be other than of local origin, and that they cannot have undergone any considerable amount of rolling.

Hippopotamus major.—The bones of this species are numerous, and in such integrity of preservation as I believe have nowhere as yet been met with elsewhere in Great Britain, with the exception of the remains found in the Valley of the Aire, near Leeds. Of these, the most remarkable are the bones of a right fore-leg, consisting of the humerus (No. 1) and united radius and ulna (No. 2), perfectly entire, of an adult animal. The articular surfaces of the bones are as smooth and perfect as if they had been yielded by a recent animal. Dimensions of humerus:—

Extreme length, outer side, 20· in. Extreme length, inner side, 17·75 in. Girth of lower articulation, 20· in. Transverse diameter of articular surface, 4·3 in. Girth of shaft at constriction, 10· in. Girth of ditto at tuberosity, 12·5 in. Girth of ditto above tuberosity, 12·75 in. Girth of articular head and bicipital tuberosity, 21·5 in. Antero-posterior diameter, 9· in. Transverse diameter of articular head alone, 4·4 in. Antero-posterior ditto, 4·3 in.

The right radius and ulna are completely anchylosed, with the ex-

[1] These notes were written in March 1863, but were never published. The collection of bones to which they refer is in the Museum of the Geological Society. Dr. Falconer's Note-books also contain full descriptions of fossils from similar excavations, in Mr. Mackie's collection at Folkestone.—[ED.]

[2] Blank in MS.—[ED.]

ception of a small fissure, proving them to have belonged to an adult animal. The articular surfaces and olecranon are perfectly entire, and there is no appearance anywhere of gnawing.

Dimensions.—Extreme length of radius, measured in front, 13· in. Extreme length of ulna, measured along the curve to olecranon, 17· in. Extreme length of ditto measured straight from top of olecranon to outer articular edge, 17·5 in. Girth of lower articular head, 16· in. Girth of united shafts, 11·5 in. Girth of united upper articular surfaces, 14·5 in. Transverse diameter of articulation with humerus, 4·2 in. Vertical height of ditto to hook of olecranon, 2·8 in.

No. 3. *Right Scapula.*—About half of this bone remains in a state of integrity, what is wanting having been lost by recent fractures. The glenoid cavity is perfectly entire, with a large projecting tuberosity; the spine and crochet are broken off, and all the basal and leafy portion near the base.

Dimensions.—Antero-posterior diameter of glenoid cup, 4·8 in. Transverse ditto, 3·8 in. Transverse diameter of proximal end, including tuberosity, 7·2 in. Transverse diameter of neck, 4·4 in.

No. 4. *Axis.*—A superb specimen of the second vertebra nearly entire, and with the articular surfaces and the odontoid processes quite entire. The following are the dimensions:—

Transverse diameter of lower surface of body, 4·6 in. Antero-posterior ditto, 2·9 in. Transverse diameter (chord) of upper articular surface, 6·8 in. Height of body to summit of odontoid, 6· in. Antero-posterior diameter of united body and spinous process, 7·8 in. Transverse diameter of the spinal foramen, 2·2 in. Antero-posterior ditto, 1·6 in.

The only parts wanting of this fine specimen are the left inferior oblique process and the upper part of the spine, both of which have been lost by a recent fracture.

Besides the axis there are three other cervical vertebræ (Nos. 5, 6, and 7), one of which is perfect, with the exception of the spinous process; another has the body perfect, but is minus the spinal arch; and a third shows only the body. The next specimen to be noticed is a perfect metacarpal or metatarsal bone, probably a metatarsal, but the exact position of which has not yet been determined. There is no specimen of a canine or incisor of Hippopotamus, but, strange to say, one detached true molar (No. 8), which has undergone more rolling than all the rest of the bones together.

Dimensions.—Length of crown, 2·3 in.; transverse ditto, about 1·5 in.

Cervus eurycerus (Irish Elk).—The determinable specimens of this species consist of the frontal part of the cranial box, together with the surfaces left by two shed horns; a considerable portion of the skull-cavity (for the cerebrum) is also shown, but all the rest of the skull is wanting (No. 9). The frontal plateau exhibits the sudden fall with the two depressions below the horn-pedicles characteristic of the species, and on the left side also a portion of the orbit, together with the characteristic supraorbitary foramen. Although mutilated, this cranial fragment leaves no doubt that the species was the Irish Elk, and in mineral condition it agrees entirely with the Hippopotamus bones, and what remains of it is in an equally unrolled condition.

No. 10 is a basal fragment off the beam of the right antler of the Irish Elk, a shed specimen. The cicatrix of the shed surface is smooth and distinctly marked; the brow-antler had been broken off before embedding, but the fractured surface obscured by matrix is visible. The upper extremity of the fragment is rough and unequal, showing that it also had been fractured before embedding.

Dimensions.—Extreme length of specimen, about 8· in. Girth at bur, 12· in. Girth of shaft above brow-antler, 9· in.

The basal surface shows the usual oblique insertion characteristic of the species.

No. 11. *Rhinoceros.*—Fragment comprising the inferior half of the right humerus, broken off a little above the constriction; unfortunately the tuberosity above the outer articular surface has been broken off, preventing a close comparison with a corresponding specimen of *R. tichorhinus* from Lawford, near Rugby, belonging to the series described by Dr. Buckland in the 'Reliquiæ Diluvianæ.'

The following are the dimensions compared with that specimen:—

	Folkestone	R. tich. Lawford
Transverse diameter of articulating surface, outer side, near middle	3·8	4·8
Antero-posterior diameter of larger articulating division	3·6	4·2
Girth of shaft at constricted portion	8·75	11·25
Extreme length of fragment	8·5	

The lower articular surface is completely united to the shaft, proving that the animal was adult, and the size and form of the specimen, so far as a comparison can be instituted, differs so decidedly from that of *Rhinoceros tichorhinus* that it probably belongs to another species, which may be *R. hemitœchus*, as I found in Mr. Mackie's collection at Folkestone, from corresponding excavations there, a singularly perfect last true upper molar of *R. hemitœchus.*

No. 12.—The corresponding part of the left humerus subsequently found, but minus the articular head. It agrees exactly in size with the other half.

No. 13 is a fragment of the shaft of the femur comprising the middle portion immediately above the condyles, the expanded part of the third tuberosity, and on the inner side the rough portion immediately below the articular head; both articulations are unfortunately wanting, and the hooked terminal part of the third trochanter is also broken off. There are, therefore, no decisive characters left to determine the species with certainty, but in all its proportions, and, in general form, it differs from the corresponding parts of *Rhinoceros tichorhinus.* The muscular ridges and depressions are in very bold relief, proving that the animal must have been very old. The dimensions are:—

Length of fragment, 11· in. Girth at constricted portion of shaft below third trochanter, 8·75 in.

Nos. 14, 15, 16, 17. *Elephas.*—Species unknown; three fragments of a large scapula of an Elephant, very much mutilated. The proximal fragment exhibits a portion of the glenoid surface; but there is nothing to show what the species was, whether *E. primigenius* or *E. antiquus,* both of which I found to occur in the Folkestone deposit by Mr.

Mackie's collection. These are all the determinable fragments referable to Elephas.

No. 18. *Bison priscus.*—A fine specimen of the cranial box, comprising the whole of the occipital, the condyles, the base of sphenoid, and a considerable part of both temporal fossæ; but the whole of the frontal, and indeed all in front of the occipital crest broken off by a very irregular fracture; quite enough, however, remains of the occiput and temporal fossæ to determine the offset of the horns and to prove that the species is *Bison priscus*. The sutures are so open as to show that the animal, although adult, was not very old. The following are the principal determinable dimensions:—

	Folkestone specimen	Museum specimen
Transverse diameter of the two occipital condyles .	5·9	5·3
Transverse diameter of left condyle	2·8	2·2
" " foramen magnum . . .	1·6	1·7
Vertical ditto . . . . about	1·7	1·8
Height from summit of occipital crest to inferior border of foramen magnum	6·2	6·4
Width of occiput between terminations of temporal fossæ	7·6	7·5

No. 19.—Fragment of a horn-core, very much mutilated, and forming the middle portion, probably of the right side, 10 inches long, and 11·5 inches where thickest.

No. 20.—*Left scapula* of a large Ruminant, showing the whole of the glenoid surface,[1] the greater part of the salient crest and the thin basal portion alone wanting. The rough muscular impressions prove distinctly that it must have been yielded by a very old animal. The following are the dimensions:—

Transverse diameter of glenoid surface, 3·8 in. Antero-posterior ditto, 3·1 in. Width of neck where constricted, 3 6 in.

This scapula belongs probably to *Bos priscus*, but this determination is approximative.

No. 21. *Right scapula.*—Corresponding very closely in general form and fracture with the specimen last described, but of smaller size, and somewhat different in form, being more slender and somewhat differently formed. It also shows the whole of the glenoid surface and the greater part of the spine; it is proved by the muscular rugosities to have been yielded by an extremely old animal.

Dimensions.—Transverse diameter of glenoid cavity, 3·3 in. Antero-posterior ditto, 2 7 in. Transverse diameter at neck, 3·4 in.

This specimen may be of the Irish Elk. The glenoid surface is singularly perfect, and free from any show of rolling.

No. 22. *Large Ruminant.*—Fine specimen, comprising the inferior half of the left humerus of a large Ruminant, most probably *Bos priscus*. The only deficiency is in a portion of the outer articular surface by recent injury.

Dimensions.—Width of articular surface, lower, 1·4 in. Antero-posterior diameter of outer condyle and tuberosity, 4·5 in. Girth of shaft, 8·5 in. Width of fissure behind, for hook of olecranon, 1·3 in.

[1] The glenoid surface of this specimen is as perfect as if it had been that of a recent animal. There is no mark of gnawing or rolling.

No. 23.—A corresponding left humerus, but without articular surface.

No. 24.—*Radius and ulna* united, of a large Ruminant, corresponding exactly in size with the humerus just noticed, but belonging to the opposite side (right). It is in the most perfect state of entirety, with the exception of the olecranon, which is broken off. The upper and lower articular surfaces are quite perfect. The following are the dimensions:—

Extreme length, 15·5 in. Girth (least), 8· in. Transverse diameter, lower articular surface, 4·5 in. Antero-posterior ditto, 2·5 in. Transverse diameter upper head, 4·6 in. Transverse diameter, upper articular surface, 4·3 in. Antero-posterior ditto, where greatest, 2·2 in.

No. 25.—Mutilated fragment in two pieces of the central part of the shaft of a metacarpal or metatarsal of a large Ruminant, probably metatarsal; indeterminable.

No. 26. *Large Ruminant.*—Atlas vertebra of a very large Ruminant, mutilated, the wings of the transverse processes being broken off; it is probably that of *Bison priscus*, but not certain.

Height of body from articular edge to articular edge, 4·3 in. Antero-posterior diameter of condyloid surface, 2· in. Transverse ditto, 2·4 in. Antero-posterior diameter of spinal canal, 2·3 in. Antero-posterior diameter of body from tuberosity to tuberosity, 4·4 in.

The specimen is small for the skull of *Bison priscus*, although it probably belongs to that species.

No. 27 is another atlas, more perfect, and probably that of Irish Elk.

No. 28. *Cervus Tarandus* (Reindeer).—Basal part of the antler comprising a short part of the beam, the brow-antler very much depressed and given off in a line with the bur. There is barely enough to determine what it is, the specimen appearing in the same mineral condition as the other remains.

No. 29.—Cervical vertebra of a Ruminant, minus the anterior part of the body. The rest perfect, probably of *Cervus eurycerus*.

No. 30.—Another more perfect, but minus the spinal arch and the processes on one side.

No. 31.—A dorsal vertebra of a large Ruminant of very large size, and extremely old, probably *Bos priscus*

Nos. 32, 33.—Two lower ends of tibia, probably of *Bos priscus* (right and left).

No. 34. *Sus.*—Fragment of right ramus of lower jaw broken off, in front of the penultimate molar, and behind by a rugged fracture through the ascending ramus; has a very rolled appearance, and has no teeth, the alveoli being filled up with matrix.

No. 35.—A corresponding fragment of the lower jaw of a large Ruminant, either *Bos priscus* or the Irish Elk.

No. 36.—Body of the vertebra of a Ruminant, probably cervical, but very much mutilated.

No. 36*a*.—Detached fragment of a large cervical vertebra, comprising nearly the superior and inferior oblique processes, probably of *Bison priscus.*

Nos. 37, 38, 39.—Three splintered fragments of the horn of *Cervus eurycerus.*

Nos. 40, 41, 42, 43.—Four splintered fragments of leg-bones of a large Ruminant; indeterminable, but probably of *Bison priscus*.

No. 44.—Articular head of the femur of one of the large Ungulata; detached from the shaft, and undetermined; greatest diameter 3·8 inches.

No. 45.—Portion of a scapula; intermediate part; probably of Rhinoceros.

No. 46.—Fragment of an axis vertebra of a Ruminant.

No. 47.—Basi-sphenoid and occipital condyles, with foramen magnum of a large Ruminant.

No. 48.—Fragment of a large flat rib, 2·6 inches wide; species undetermined.

No. 49.—Point of snag of a large Cervine antler; undeterminable.

No. 50.—Basal fragment of a horn-core of a large Ruminant, probably *Bos priscus*.

Nos. 51, 52, 53.—Three large bone splinters; undetermined.

No. 54.—A rolled iliac bone; undetermined.

No. 55.—Fragment of a large rib, probably Elephant; much rolled.

Nos. 56–63.—Eight fragments of the frontal portion of the skull of a large Ruminant, and probably derived from the cranium of *Bison priscus*, No. 18, but undeterminable.

No. 64.—A bone splinter; undetermined.

Nos. 65, 66.—Two bone fragments, to be determined.

No. 67.—A bone splinter, to be determined.

No. 68.—Mutilated portion of a right humerus of Rhinoceros, lower end, like No. 11, but very much mutilated, and barely determinable.

XXIV. PRIMEVAL MAN, AND HIS COTEMPORARIES.[1]

Opinionum commenta delet dies, naturæ judicia confirmat.
Cicero 'de Natura Deor.' lib. ii. cap. 2.

. . . Fabricated and used by a people who had not the use of metals. . . . The situation in which these (flint) weapons were found may tempt us to refer them to a very remote period indeed, even beyond that of the present world.
JOHN FRERE, Esq., F.R.S., F.A.S., 22nd June, 1797.
'Archæologia,' 1800, vol. xiii. p. 204.

PREFATORY NOTE.

THE AUTHOR feels that he comes before the public at great disadvantage with the present work. He is late in making his appearance in a field in which he has been preceded by a digest of the whole subject, produced by a philosophical writer of high eminence and authority. But he has confidence that men of science, and educated readers of all classes, will take an interest in knowing from one of the practical observers the steps by which the now generally accepted belief in the remote antiquity of the human race has been led up to its present advanced condition; and that they will not be indifferent to a narrative of the labours of those who have pursued the inquiry alike through bad and good repute, and who have contributed to it the greatest impulse. For in casting a retrospective glance on the history of any great question concerning the advancement of human knowledge, with a view of awarding to each inquirer his due share of desert, we must revert to the state in which the subject was when they successively struck us. Once fairly launched and accredited, the evidence with the conviction founded upon it accumulates, like a snow-ball when set in motion. The present work is intended mainly *pour servir*, in the history of science, as a vindication of the part taken by the author and his friends, M. Boucher de Perthes and Mr. Prestwich, in the investigation of the remote antiquity of the human race upon the palæontological and geological evidence.

[1] The following important historical Essay was written in 1863, and was intended as an introduction to a distinct work with the above title, the object of which was to set forth the physical proofs of the remote antiquity of the human race, and the physical condition of the earth's crust prior to, and at the date of, man's first appearance.—[ED.]

Primeval Man, and His Cotemporaries.

INTRODUCTORY REMARKS.

I.

The geological proofs of the antiquity of the human race have recently attracted a large measure of attention both among men of science and among educated minds of all classes. The question by common consent is admitted to be one of the most important which has been raised of late years; it is further generally admitted that it has made advanced progress towards a secure basis of demonstration, and that English observers have given the greatest impulse to the inquiry. They prefer no claim to have been the first in the field; but when the inferences arrived at by the earlier inquirers were either forgotten or discredited, whether from suspicion of the evidence, from the undue weight of opposed authority, or from deep-rooted prejudices in favour of established opinions, they reopened the question upon fresh observations, and tested the facts with such scrupulous care, that they speedily carried with them the convictions of men of science of all countries. Among these leading observers, Mr. Prestwich, in one walk of the investigation, beyond all others holds the first rank. Once fairly launched, in 1858-59, the subject excited lively interest; the field was soon occupied by a host of labourers; additional evidence poured in from various quarters; and one important contribution was exhumed from the published transactions of a learned society, where it had slumbered for sixty years in undisturbed repose.

My attention has been directed to the subject, more or less continually, during many years of palæontological research, and I propose to give a brief narrative of the circumstances which lead me to take up the question of the antiquity of the human race, in order to satisfy my readers that I do not now approach the subject wholly unprepared by antecedent study.

II.

The vast expanse of the plains of Hindostan consists of a fundamental stratum of very ancient alluvium, which is developed in great force. It is longitudinally traversed, after their escape from the Himalayah Mountains, by the Ganges and Jumna rivers, which unite at Allahabad. Be-

tween Agra and that station the fall of the country is considerable, and the waters of the Jumna have produced the usual effects of river-action operations during a long lapse of ages. The stream had gradually cut its way down through the 'Ancient Alluvium' to a depth of from 100 to 140 feet below the level of the adjacent plains, thus exposing a very instructive section of great extent. The 'Ancient Alluvium' here spoken of consists of beds of sand and clay, containing embedded in them enormous quantities of the impure calcareous aggregations called nodular *Kankar*, and commonly, at the bottom of the section, partial beds composed of tabular masses of *Slab-kankar*, which are removed for architectural purposes.[1] In scouring the channel down through the Ancient Alluvium, the course of the river has intersected these beds of *Slab-kankar*, which form, here and there, subaqueous reefs obstructing the navigation of the river. The Government of India, in 1828, undertook a series of operations, which extended over seven years, for the removal of these and other obstacles, from the bed of the Jumna. They were conducted chiefly by Captain Edward Smith, an accomplished officer of the Bengal Engineers. Fossil bones of extinct Mammalia were discovered, in great abundance, below the tabular extensions of *Slab-kankar*, which, beyond question, is a formation of very great antiquity and long antecedent to the flow of the present channel of the Jumna. Captain Smith believed that among these osseous remains he had detected human bones, some of which have been figured.[2] But after submitting them to a close examination, to which I shall have occasion to refer in the sequel, the identifications proved to be untrustworthy or erroneous. Another observation, however, was made by Captain Smith, upon which, as a professional expert, he was competent to give an authoritative opinion; namely, that some of the fossil bones 'were dug from depths of 6 to 18 inches in the firm shoal, which is composed of substances (*sic*) *kankar* stone, rounded bricks (vitrified clay?) more or less rolled and cemented by mud and clay.'[3] These observations, published in 1833, excited lively interest and discussion in the Indian scientific journals. Mr. James Prinsep referred,

[1] The nodular *kankar* of India, although on a much greater scale of aggregation, is identical in its nature and composition with the impure calcareous nodules called '*Race*,' which are so abundant in the 'Brick-earth' deposits of the Valley of the Thames· '*Race*,' from their resemblance in form to a rhizoma or Race of Ginger. The tabular *kankar* is not represented in England by any equivalent deposits; but although more impure, it resembles the travertine of the 'Mammoth Felder,' at Cannstadt.

[2] Journ. Asiat. Soc. of Beng. 1833, vol. ii. p. 630, Pl. xxv.

[3] *Loc. cit.*

in connection with them, to the then recent inferences arrived at by Marcel de Serres, Christol, and Tournal, regarding the human bones found in caverns in the south of France, and used the following terms in his notes '*On the Occurrence of the Bones of Man in the Fossil State*': — 'The problem being thus resolved, it follows that man must also be included among the fossil species, or rather that the sudden transition from one condition of being to another must be disallowed, and that the same gradual alteration of species, already so fully developed by M. Deshayes in his comparison of the fossil shells of the different periods of the tertiary formations, must be extended to animals, and perchance to man himself: in fact, that the barrier of fossil and non-fossil must henceforth be a distinction of convenience only, to separate such remains as may be found buried in the regular geological strata, from those of more modern or accidental inhumation.' [1]

In 1835, while the interest of these Jumna explorations was still fresh, Capt. (now Colonel Sir Proby) Cautley and myself, then occupied with the investigation of the Fossil Fauna of the Sewalik hills, discovered the remains of the extinct gigantic Tortoise of India. This remarkable form was briefly referred to in a memoir communicated to the Geological Society in 1836; but the detailed account of it did not appear until 1844. The huge chelonian was inferred to have had a shell twelve feet long, eight feet in diameter, and six feet high; and the anterior or episternal portion of the plastron exhibited a thickness of 6½ inches of solid bone; proportions which rendered it a fit object for comparison with the Elephant. The following remarks bearing upon its possible relations to the human period are extracted from the 'Proceedings' of the Zoological Society in 1844: [2]

'*Colossochelys Atlas.*—The first fossil remains of this colossal Tortoise were discovered by us in 1835 in the tertiary strata of the Sewalik hills, or Sub-Himalayahs skirting the southern foot of the great Himalayah chain. They were found associated with the remains of four extinct species of Mastodon and Elephant, species of Rhinoceros, Hippopotamus, Horse, Anoplotherium,[3] Camel, Giraffe, Sivatherium, and a vast number of other Mammalia, including four or five species of Quadrumana. The Sewalik Fauna included also a great number of reptilian forms, such as Crocodiles and land and freshwater Tortoises. Some of the Crocodiles belong to extinct species, but others appear to be absolutely identical with species now living in the rivers of India: we allude in particular to the *Crocodilus longirostris*,[4] from the existing

[1] Journ. Asiat. Soc. Bengal, 1833, vol. ii. p. 634.

[2] See vol. i. p. 365.—[Ed.]

[3] Now *Chalicotherium Sivalense*, being *Nestoritherium* of Kaup. [See vol. i. p. 223.—Ed.]

[4] *Gavialis Gangeticus.*

forms of which we have been unable to detect any difference in heads dug out of the Sewalik hills. The same result applies to the existing *Emys tectum*,[1] now a common species found in all parts of India. . . . This is not the place to enter upon the geological question of the age of the Sewalik strata; suffice it to say, that the general bearing of the evidence is that they belong to the newer Tertiary period. But another question arises: "Are there any indications as to when this gigantic Tortoise became extinct? or are there grounds for entertaining the opinion that it may have descended to the human period?" Any *a priori* improbability that an animal so hugely disproportionate to existing species should have lived down to be contemporary with man is destroyed by the fact that other species of Chelonians which were coeval with the *Colossochelys* in the same Fauna have reached to the present time; and what is true in this respect of one species in a tribe may be equally true of every other placed under the same circumstances. We have as yet no direct evidence to the point, from remains dug out of recent alluvial deposits, nor is there any historical testimony confirming it; but there are traditions connected with the cosmogonic speculations of almost all Eastern nations, having reference to a Tortoise of such gigantic size as to be associated in their fabulous accounts with the Elephant. Was this Tortoise a mere creature of the imagination, or was the idea of it drawn from a reality, like the *Colossochelys*?' . . .

Reference is then made to the most remarkable cases in which the Tortoise figures in mythological conceptions that are traceable to an Oriental source: first, in the Pythagorean cosmogany, where the infant world is represented as having been placed on the back of an Elephant which was sustained on a huge Tortoise; next, to the Second Avatar of Vishnoo, in Hindoo mythology, where the god is made to assume the form of a Tortoise, and to have sustained the newly-created world on his back, to make it stable; and, lastly, to the exploits of the bird-demigod *Garŭda*, during one of which he was directed by his father, *Kŭshyŭpa*, to appease his hunger at a certain lake where *an Elephant and Tortoise were fighting*. The dimensions of both are expressed in figures of extravagant magnitude. *Garŭda* with one claw seized the Elephant, with the other the Tortoise, and flew to a mountain, where he regaled himself with the viands yielded by the two animals. The speculative remarks, suggested by these traditions, viewed in connection with the discovery of the *Colossochelys* were expressed in the following terms:—

'In these three instances, taken from Pythagoras and the Hindoo mythology, we have reference to a gigantic form of Tortoise, comparable in size with the Elephant. Hence the question arises, are we to consider the idea as a mere figment of the imagination, like the Minotaur and the Chimæra, the Griffin, the Dragon, and the Cartazo-

[1] See vol. i. p. 382, *note* 2.—[Ed.]

non, &c., or as founded on some justifying reality? The Greek and Persian monsters are composed of fanciful and wild combinations of different portions of known animals into impossible forms, and, as Cuvier fitly remarks, they are merely the progeny of uncurbed imagination; but in the Indian cosmogonic forms we may trace an image of congruity through the cloud of exaggeration with which they are invested. We have the Elephant then, as at present, the largest of land animals, a fit supporter of the infant world; in the serpent Asokee, used at the churning of the ocean, we may trace a representative of the gigantic Indian Python; and in the bird-god Garūda, with all his attributes, we may detect the gigantic Crane of India (*Ciconia gigantea*) as supplying the origin. In like manner, the *Colossochelys* would

Fig. 8.

THE ELEPHANT VICTORIOUS OVER THE TORTOISE, SUPPORTING THE WORLD, AND UNFOLDING THE MYSTERIES OF THE FAUNA SIVALENSIS. FROM A SKETCH IN PENCIL IN ONE OF DR. FALCONER'S NOTE-BOOKS BY THE LATE PROF. EDWARD FORBES.

supply a consistent representative of the Tortoise that sustained the Elephant and the world together. But if we are to suppose that the mythological notion of the Tortoise was derived, as a symbol of strength, from some one of those small species which are now known to exist in India, this congruity of ideas, this harmony of representation, would be at once violated; it would be as legitimate to talk of a Rat or a Mouse contending with an Elephant as of any known Indian Tortoise to do the same in the case of the fable of Garūda. The fancy would scout the image as incongruous, and the weight even of mythology would not be strong enough to enforce it on the faith of the most superstitious epoch of the human race.

'But the indications of mythological tradition are in every case vague and uncertain, and in the present instance we would not lay undue weight on the tendencies of such as concern the Tortoise. We have

entered so much at length on them on this occasion, from the important bearing which the point has on a very remarkable matter of early belief entertained by a large portion of the human race. The result at which we have arrived is, that there are fair grounds for entertaining the belief as probable that the *Colossochelys Atlas* may have lived down to an early epoch of the human period, and become extinct since:—1st, from the fact that other Chelonian species and Crocodiles, contemporaries of the *Colossochelys* in the Sewalik Fauna, have survived; 2nd, from the indications of mythology in regard to a gigantic species of Tortoise in India.'—Proceed. Zool. Soc. Lond. 1844. Part xii. p. 85.[1]

It is not meant to be urged now, after a lapse of more than twenty years, that any serious claim can be preferred on the speculation put forward in the passages above cited. But it will perhaps be admitted that the mind of the observer from whom it emanated was then occupied with the subject of the possibility of the remote antiquity of man in India, on palæontological evidence.[2] It is true that the expressed view is that the Colossochelys may have lived down to an early epoch of the human period; and not that man had lived back to be a cotemporary of the Tortoise, now proved to have been Miocene. But the two views are reciprocal; and the form of expression selected on the occasion was that which was least calculated to provoke ridicule, or to shock the strong prejudices on the subject which were then dominant among educated men. And so firmly was—not merely the possibility, but—the probability of the case impressed upon our minds, that Capt. Cautley and myself were constantly on the look-out for the turning up, in some shape or other, of evidences of man out of the strata of the Sewalik hills, partly from considerations of a different order, to which I shall briefly allude.

The cataclysmic speculations of Cuvier and the Diluvial theory of Buckland were then exploded. The wide spread of the plains of India showed no signs of the unstratified superficial Gravels, Sands, and Clays, which for a long time were confidently adduced as evidence that a great Diluvial wave had suddenly passed over Europe and other continents, overwhelming terrestrial life, and leaving the marks of its course and violent action in these enormous deposits of transported debris. Every section along the Gangetic plain indicated that the superficial strata there were of local origin, and the result of tranquil sedimentary deposition. Viewed in the light of a strictly physical inquiry, the chief

[1] Reproduced in vol. i. p. 368.—[Ed.]

[2] As additional evidence on this point, the reader is referred to the note appended to the memoir on *tecta*, written in 1844. See vol. i. p. 388.—[Ed.]

rational argument in support of the opinion that the advent of man upon the earth dates from a very modern epoch, was first, the negative evidence in the non-occurrence of human relics, and next the fact, that taking him in conjunction with the Mammals, with whom he is now associated, they appeared, as a group, to belong to a new order of things strikingly different from that of the immediately preceding period. The Mammoths, the wool-clad Rhinoceros, the Cave-Lions, and Spelæan Hyænas, the Irish Elk, &c. of the European fauna were all extinct, although the carcasses of some of them had been discovered, under favourable circumstances, in the most perfect state of preservation. Facts of corresponding import were yielded by a glance cast upon the latest palæontology of the American Continent. There also the huge extinct Edentata, the Mammoth, and the Mastodon indicated a different order of life, especially from that now existing. But in India the problem presented itself under another aspect. There, no break was visible in the tranquil succession of deposits, no interference of a general oceanic submergence, followed by incoherent beds of sand and gravel, no intercalation of glacial phenomena to disturb the previous system. The present physical order of things—modified only by alterations of level, by upheavements and depressions—could be traced back, in an unbroken chain, to the ossiferous strata of the Valley of the Nerbudda and of the Sewalik hills. Results in harmony with these indications were yielded by a retrospect cast upon the system of organized life. The *Mastodons*, the *Stegodons*, and the *Loxodon* Elephants were extinct, as were also the *Sivatherium*, the *Chalicotherium*, the three-toed *Hipparion-Horse*, the *Hexaprotodon*, the *Merycopotamus*, and other peculiar forms. But they were found associated in the same Sewalik deposits with species of true *Equus*, of Camel and of Giraffe, the two last being characteristic cotemporaries of man at the present time. The Pliocene fauna of the Nerbudda Valley produced, along with the Miocene *Stegodon insignis* of the Sewalik hills, an extinct Elephant, *E. Namadicus*, the dental system of which is closely allied to that of the existing Indian species; a true *Hippopotamus*, and not to mention others, a true Taurine Ox, *Bos Namadicus*, and a huge Buffalo, *B.* (*Bubalus*) *Palæindicus*, which is nearly approached by the living 'Arnee' of the forests of Assam, being the stock from which the domestic Buffalo of Oriental countries is supposed to have sprung. That the actual order of the present system of life had begun during the Sewalik period, was indicated by the living Gharial[1] Crocodile and *Emys tecta*,

[1] See vol. i. p. 350, *note* 1.—[Ed.]

referred to in the above extract as being found associated with the extinct mammalian forms. And of the latter, some, like *Stegodon insignis*, accompanied by a species of *Hexaprotodon*, descended to the Pliocene period of the Nerbudda fauna, to be associated with a true Taurine Ox and with a Buffalo which hardly appears to differ more from the living *Arnee* than does the ancient *Bison priscus* from the living Aurochs. Another fact chimed in with especial force. Among the four or five species of Sewalik Quadrumana alluded to above, one was inferred by Sir Proby Cautley and myself, in 1837, to have been a large Ape, exceeding the size of the Orang-Outang, but of unknown immediate affinity. This opinion was founded upon a canine tooth of an old animal, which is figured and described in the Journal of the Asiatic Society of Bengal.[1] Five years afterwards, in 1842, I instituted a close comparison between the fossil specimen and the corresponding tooth of three skulls of the Orang-Outang, contained in the Museum of the Asiatic Society in Calcutta, and found that their agreement was so close, that I conjectured that the extinct Sewalik form had been a large Ape allied to *Pithecus satyrus*.[2]

A quadrumanous astragalus, derived from the same strata, approached, in form and proportions, so near to that of the existing Hoonuman Monkey, *Semnopithecus entellus*, that the help of the callipers had to be put in requisition to enable us, in 1836, to discriminate them, by differences not exceeding millimètres. The distinction between the fossil and the recent bone is hardly greater than that which might be expected to occur in any two individuals of the living species.[3] Here, then, was clear evidence, physical and organic, that the present order of things had set in from a very remote period in India. Every condition was suited to the requirements of man. The lower animals which approach him nearest in physical structure were already numerous. The wild stocks from which he trains races to bear his yoke in domesticity were established. Why then, in the light of a natural inquiry, might not the human race have made its appearance at that time in the same region? Cuvier, notwithstanding his strong bias in favour of the modern appearance of the human race, admitted, in language which has often been overlooked in later discussions, that man may have lived before the last great revolutions which were the subject of his disquisition:—'Tout porte donc à croire que l'espèce humaine n'existait point dans les pays où se découvrent les os fossiles, à l'époque des révolutions qui ont enfoui

[1] Vol. vi p 359, Pl xviii fig c.
[2] See vol. i p. 304.—[Ed]
[3] See vol. i. p 294.—[Ed]

ces os; car il n'y aurait eu aucune raison pour qu'elle échappât toute entière à des catastrophes aussi générales, et pour que ses restes ne se retrouvassent pas aujourd'hui comme ceux des autres animaux; mais je n'en veux pas conclure que l'homme n'existait du tout avant cette époque. Il pouvait habiter quelques contrées peu étendues, d'où il a repeuplé la terre après ces évènements terribles,' &c. The Valley of the Ganges seemed to present the exceptional conditions here demanded; it was exempt from the protracted submergence under the ocean, the effects of which on Europe suggested the idea of cataclysmic revolutions. I dwell upon the subject now in the hope that, when the palæontological exploration of the Sewalik hills and Nerbudda Valley, or of other equivalent formations, is resumed, these remarks may attract attention in India, and that a keen look-out may be kept up for remains of the large fossil Ape above alluded to, and for traces of man, in some form of equally remote antiquity. For it is not under the hard conditions of the Glacial period in Europe, that the earliest relics of the human race upon the globe are to be sought. Like the Esquimaux, the Tchuktshes, and the Samoyedes on the shores of the Icy Sea at the present day, man must have been then and there an emigrant, placed under circumstances of vigorous and uncertain existence, unfavourable to the struggle of life and to the maintenance and spread of the species. It is rather in the great alluvial valleys of tropical or sub-tropical rivers like the Ganges, the Irrawaddi, and the Nile, where we may expect to detect the vestiges of his earliest abode. It is there where the necessaries of life are produced by nature in the greatest variety and profusion, and obtained with the smallest effort; there, where climate exacts the least protection against the vicissitudes of the weather; and there, where the lower animals which approach nearest to man now exist, and where their fossil remains turn up in the greatest variety and abundance. The earliest date to which man has as yet been traced back in Europe is probably but as yesterday, in comparison with the epoch at which he made his appearance in more favoured regions.

III.

The next case to which I shall refer occurs in the prefatory remarks of a published catalogue[1] of Indian fossil

[1] Descriptive Catalogue of the Fossil Remains of Vertebrata from the Sewalik hills, &c., in the Museum of the Asiatic Society of Bengal, by H. Falconer, M.D., F.R.S., assisted by H. Walker, Esq. 8vo. Calcutta, 1859, p. 7.

remains, bearing the date of February 28, 1855, from which the following observations are extracted:—

'The Jumna Alluvium collection consists of specimens in part presented by Captain E. Smith and Lieutenant Burt of the Engineers, but the great number by Sergeant E. Dean.

'Captain Smith's specimens were readily discovered, and among them, besides those enumerated and figured in the Journal, I found the perfect astragalus of a *Hippopotamus* distinct from the Sewalik Hill species, and apparently identical with the Nerbudda *Tetraprotodon.* But Sergeant Dean's series proved to be in such confusion, that under the pressure of an approaching departure for Europe, I felt that I could not afford them the time they required, and left them unarranged. . . . I regret this the more, as I consider the Jumna fossils to be the *most promising of results bearing upon the human period*, and I strongly recommend them to any one who is able and willing to undertake the task of investigating them.'[1]

IV.

I shall now pass to the more immediate researches on the same subject with which I have been connected in Europe.

Strange and improbable as the assertion may appear, it is nevertheless true, that the most superficial deposits of the earth's crust, forming the very ground under our feet, have been in many respects the least satisfactorily investigated of geological formations. The Palæozoic rocks at the most distant extremity of the chain of life upon the globe have, by an admirable series of researches by great observers, been

[1] The fossil remains here mentioned are those to which allusion has been made (p. 572) as having been yielded by the Ancient Alluvium of the Jumna. Much precious material was irretrievably lost from heedlessness during the earlier part of the seven years' operations: but enough was preserved to be of high interest. The supposed Human Bones proved to be either inconclusive or mistaken determinations. But among the other fossils I identified a molar tooth of the extinct *Elephas Namadicus*, a lower jaw with teeth and a perfect astragalus of the true Indian Hippopotamus, *H.* (*Tetraprotodon*) *Palæindicus*, both forms belonging to the Pliocene fauna of the Nerbudda Valley. The ancient Indian Hippopotamus differs in a very essential manner from the existing African species, the large and small pairs of incisors of the jaws occupying reversed positions respectively in the two species. A quadruped so remarkable for its size, form, and habits, must everywhere have impressed itself forcibly on the attention of man; and the question arose: could, as in the instance of the 'Gigantic Tortoise,' any reflection of its former existence be detected in the ancient traditions or languages of India? Following up the inquiry, I was informed by Raja Radhakanta Deva, the eminent Indian scholar and author of the Sanscrit Encyclopædia, that the *Hippopotamus* of India is referred to under different names of great antiquity, significant of *Jala-Hasti*, 'Water-Elephant,' or 'Living in the water.' This inference is confirmed by the opinion of Henry Colebrooke and H. H. Wilson. No definite result was arrived at; but referring to the line in italics contained in the above extract, there is published evidence that in 1855 I was engaged, in connection with palæontological researches, upon the same question to which my attention was directed between 1836 and 1844, namely the remote existence of the human race in India.

dressed into exquisite order, each successive formation unfolding the record of the organized beings which were then in existence, and to a great extent also the physical conditions under which they lived. The series of rocks called Secondary and Tertiary, which are the cemeteries of the Mesozoic and Kainozoic creatures that formed the mid-stages of world-life, have been subjected to a similar course of analysis, and have yielded corresponding results. But the nearer we approach to the existing system, of which man is the head and chief, the more hazy has the prospect been—the more faint and obscure the definition of the outline. The reason is sufficiently obvious. All the great disclosed problems that were most calculated to fascinate the imagination and exercise the intellectual powers lay in the remote past. It was there where the medals were buried, by the interpretation of which the prodigious antiquity of our planet, as a field of life, has been established; and there, where the vast forces which have rent its coast asunder were, by their effects, most distinctly evinced. There was an irresistible charm in tracing back the firstlings of life to their earliest dawn in the Cambrian and Silurian rocks, and in following the progress upwards from simple to more advanced forms. The Secondary rocks revealed evidence that the surface of our island was formerly clothed with tropical forests, and peopled with Saurian quadrupeds, like the *Iguanodon*, the *Megalosaurus*, and the *Pterodactyle*, which, by their unexpected forms and colossal proportions, startled the imagination and taxed the synthetic powers of science to restore them. Ascending to the Tertiary series, the genius of Cuvier worthily followed up by his successors had reproduced the exuberant variety of Mammalian quadrupeds with which the Eocene and Miocene formations teemed. But in the Pliocene strata the exciting interest of novelty waned, till in the newer Quaternary deposits it became nearly evanescent. The gravels, sands, and clays, which compose them, were invested with an eminently prosaic character, little promising of food to the imagination, or of profitable exercise to the reasoning faculty; and the treatment they met with was in keeping with their uninviting aspect. They were all summarily disposed of by the convenient and lazy hypothesis of a transitory Diluvian irruption, which had swept over the earth's surface and left them behind. The keen intellect of Agassiz rent the veil of this delusion, and fixed the attention of observers upon the phenomena of glacial action, which for a time brooked no rival, but reflected a flood of light upon what was before either mistaken or obscure. Like most other fashions, it was in its day su-

preme, and every investigation of the superficial deposits was tinged, more or less, of a glacial complexion. The gravels, sands, and loams, not directly the products of glacial action, were in every respect unattractive. True that they were occasionally loaded with organic remains, the most important of these being fossil bones; but the latter were regarded in most instances as being but repetitions of what was already well known; the deposits themselves were of local origin, and in many cases their precise geological age long baffled all attempts at determination. One signal example to which frequent reference will be made in the sequel may be adduced. In the Valley of the Thames, close to the head-quarters of geological observations in England, there is an abundant development of loam and gravel deposits of freshwater origin, which are extensively excavated for brick-earth and other commercial objects. They contain beds which are charged with fluviatile shells, some being of species now extinct in England; and they are also rich in fossil bones of large Mammalia, living and extinct. Fine sections of these beds have been disclosed at Brentford, Ilford, Grays Thurrock, Erith, and other localities. The Brentford section was described fifty years ago in the 'Philosophical Transactions,' and some of the most remarkable organic remains found in it were at the same time figured.[1] The Grays Thurrock beds were closely studied by an able and experienced observer, Professor Morris, who published an excellent account of their contents in 1838. The whole series of these brick-earths, both in the Valley of the Thames and in other river valleys of the same system, has been the subject since of constant observation by some one of numerous geologists of authority, such as Godwin-Austen, Prestwich, Morris, Joshua Trimmer, Lyell, Edward Forbes, &c., yet has their true geological age, whether preglacial, *i.e.* anterior to the submergence of the land under the glacial sea, or post-glacial, *i.e.* subsequent to its final emergence, remained up to the present time a subject of the utmost perplexity and of great difference of opinion among geologists, the reason of this being that nowhere in the Valley of the Thames was a section to be found showing the glacial drift and fluviatile deposits in contact or in order of superposition. The general physical phenomena, in the absence of direct proof, led Mr. Prestwich, Professor Morris, and the late Mr. Joshua Trimmer, to the belief that they were of a later date than the Boulder-clay, *i.e.* post-glacial, while the palæontological evidence appeared to be at issue with that inference, and to indicate that they were preglacial. The polyonomous

[1] William Trimmer, Phil. Trans. 1813.

bivalve shell *Cyrena fluminalis*, long regarded as 'pre-eminently preglacial,' from its presence in the Crag, occurs in abundance at Erith, Ilford, Grays Thurrock, and Stutton ; and from Grays Thurrock, I had determined undoubted remains of *Elephas antiquus*, Falc., and *Rhinoceros leptorhinus*, Cuvier (*R. megarhinus*, Christol), found along with *Hippopotamus major*, free from association with *Elephas primigenius*, or *Rhinoceros tichorhinus*, the two characteristic forms of the glacial deposits of Northern Europe and Siberia. The three fossil mammals of Grays above-named were identified by me as occurring in the Sub-Apennine Pliocene deposits of the Astesan, and in the preglacial lacustrine deposits or 'forest-beds' of the Norfolk coast. The weight of the palæontological evidence, molluscous and mammalian, appeared to turn the scale in favour of the preglacial view. It was only when Mr. Prestwich had discovered in sections near Holderness and Hull beds of clay, sand, and gravel, analogous to the Thames Valley deposits, containing *Cyrena fluminalis*, and clearly superimposed on the Boulder-clay, that the problem was by him satisfactorily solved, stratigraphically, in 1860. Mr. Prestwich before that time had his early convictions confirmed by sections in the Valley of the Stour, at Sudbury, and by a still more important case, in the Valley of the Ouse, near Bedford, where a bank of gravel yielded remains of Elephant, Rhinoceros, Hippopotamus, Ox, Horse, and Deer. Commencing with the labours of Mr. W. Trimmer, fifty years had lapsed before the point was finally settled ; such a vast amount of competent observation does the solution of a complex geological question of this nature involve. The same kind of mystery in reference to their precise geological age enveloped the ossiferous caves.

It had been supposed, prematurely, by some of those who had a share in the great achievements of the early days of the science, that the general field of geology was swept clean of all the grand questions which could command interest, and that it would be left to those who came after merely to fill in the details of the outlines which had been carved by the great masters who had preceded them. Vain, the complacent idea ; for even in those neglected superficial sands and gravels lay buried the evidence, upon which problems that now fix the attention of mankind were to be worked out. Boucher de Perthes, in France, was perseveringly ransacking the gravel heaps and gravel sections of the Valley of the Somme near Abbeville, for the wrought flint-weapons which are now so intimately connected with his name. They had escaped the discrimination of M. Baillon, one of the most active correspondents of Cuvier, and

a contributor to the 'Ossemens Fossiles'; but the keen glance of Boucher speedily detected their import, and his inferences received important confirmation from the subsequent discovery by Rigollot of similar flint-implements in gravel sections near Amiens. But the observations of both were either scorned or discredited. At the same time a quiet observer, of matchless sagacity and indomitable perseverance, Mr. Prestwich, was making the gravels in England an object of special investigation. Engaged during a long course of years upon the study of the European Tertiaries, he gradually worked his way up to the superficial deposits. Mr. Prestwich's researches upon the Tertiaries, which have only been partially published, have earned for him the reputation of being one of the ablest geological observers of his time. But in the Quaternary sands and gravels he was unrivalled. Men have been in the habit of saying, in mingled earnest and raillery, that 'point out a broken pebble amongst a thousand others in a gravel-pit, and there is one who will tell you the point of the compass from which it came, the stratum which yielded it, the distance it had travelled, the amount of rolling it had undergone, and the time it had occupied in the journey.' The power thus acquired was soon to be applied with clenching authority to the proofs of the antiquity of man yielded by those deposits. But to be productive, complex researches of this nature must be subjected to the economic law of division of labour, which controls alike the skilled results of artisanship in the manufacture of pins and buttons, and the intellectual efforts which contribute to the advancement of knowledge; special application in either case determines the excellence of the products. The mollusca occurring in the clays and gravels had undergone the severest scrutiny; but although commonly of such importance in geological chronology, their value as indicative agents in this case was but trivial, all the forms being of existing species. The fossil bones had also been collected and named. The authority of Cuvier in this latter walk of research was still paramount, and in most cases governed the specific determinations of the remains of the large extinct Mammalia which abound in the brick-earths and gravels. In 1844 I made excursions to various localities in the Valley of the Thames, in company with my friend the late Edward Forbes, and arrived at the conclusion that they contained the remains of extinct species that were then unrecognized. These results applied more especially to the large fossil Ungulata, and to the Elephants in particular. In Parts I., II., and III. of the 'Fauna Antiqua Sivalensis,' published in 1846 and 1847, figured evidence

was put forward that the Pliocene and Post-Pliocene formations in England yielded three distinct species of Elephant besides the Mammoth, namely *Elephas meridionalis* of Nesti, *E. antiquus*, and *E. priscus*. It was inferred also that corresponding results would follow a close study of the other Ungulate genera, such as *Rhinoceros*, but a compulsory departure to India on service, in 1847, prevented me from pursuing the investigation at the time. On my return to Europe, in 1855, fresh from the study of the fossil remains of the 'Ancient Alluvium' of the Jumna, and of their possible bearings on the antiquity of man (*antea*, p. 580), I determined to take up the examination of the extinct Mammalia of the Pliocene and Quaternary periods in Europe as a monographic labour; in short, to apply to the deposits, palæontologically, the same kind of analysis which Mr. Prestwich was applying to them stratigraphically, but without concert with or even personal knowledge of him at the time. The object held in view was, first to endeavour to determine with precision the specific characters of the Mammalian forms which occur in the Pliocene strata of the Sub-Apennines, and in equivalent formations elsewhere; next, to ascertain their range of existence in time, and then to deal in the same manner with the forms which make their appearance in the Quaternary deposits. In this way, it was expected that it would be seen when the older forms ceased, and when the newer forms came in; or whether the latter passed gradually into the former. The Mollusca appeared to fail here in an important respect as guides, the percentage of extinct species in the newer Quaternaries being either *nil* or excessively small, while the Mammalia promised to furnish a test of greater significance: 1st, because the genera and species are everywhere shown to be of more limited duration in time than the Mollusca; 2nd, because from the vastly greater complexity of their relative functions, they are much more susceptible of being affected by the altered climatic conditions which are necessarily involved in every great physical change, and which conduce most to the extinction of species.

Another object was held in view, upon which it was anticipated that the investigation might throw important light—namely, the permanence or mutability of species. Between the Pliocenes of the Sub-Apennines and the newer Quaternary formations an enormous lapse of time had intervened—amounting to many hundreds of thousands, if not millions, of years—during which a great portion of the Continents of Europe, Asia, and America had been chilled down to an extent to which the past history of our planet furnished no

known parallel. How fared it with the large Mammalia during this mighty change? Were the older forms killed off, and newer species intercalated, or did any of the former, and if so, what number, survive through it, and how were they affected? In this case the argument of the imperfection of the geological record, which has been so powerfully handled by Darwin, could not be urged; the materials were abundant, and the deposits which marked the successive changes of dry land, submergence, and re-emergence, were amply represented. I was well acquainted, through the unreserved communication of intimate friendly intercourse, with the gradual development of his views on the origin of species; and it seemed that here was a case where quadrupeds which were either cotemporaries of man or close upon his period, could be traced back into remote time, and thus furnish a test of the mutability or persistence of specific characters, of much higher value than that yielded by observation upon living animals, necessarily limited to a brief lapse of time—in fact, to the personal experience of the observer.

The results of these inquiries were, in part, communicated to the Geological Society, in 1857, in two memoirs, the first of which appeared *in extenso*, the second in abstract, in its Quarterly Journal.[1] In the former it was attempted to be shown that the principal species of the large fossil Ungulata, such as *Mastodon Arvernensis*, *Elephas meridionalis*, *Elephas antiquus*, *E. priscus*, *Rhinoceros leptorhinus* and *Hippopotamus*, might occur alike in the Sub-Apennine Pliocenes of Italy and in the Norwich Crag, indicating the formations to be of the same age. In the second, it was stated that the same extinct species, with the exception of *Mastodon Arvernensis*, are found in the 'Elephant-bed,' and Lacustrine blue clays of the Norfolk coast, which underlie the 'Boulder-clay,' proving them also to belong to the Pliocene period. Finding that the same *Elephas antiquus* and the variety called *E.* (*Loxodon*) *priscus*, along with *Rhinoceros leptorhinus* and *Hippopotamus major*, although unaccompanied by *Elephas meridionalis*, were abundant at Grays Thurrock and Brentford, I was led by the Mammalian evidence to consider that the fluviatile deposits of the Valley of the Thames were also of an earlier age than any part of the Boulder-clay. This inference my subsequent researches in the caves proved to be erroneous; and in a recent paper I have shown that the true Mammoth, *E. primigenius*, had its range of existence stretching as far back in time as the preglacial forest-bed of Norfolk, and the deposits of the ancient lake-formation of

[1] See *antea*, pp. 1 and 76.—[Ed.]

the Seven Hills upon which Rome is built, 'bearing his organs of locomotion and digestion all but unchanged,' through an enormous lapse of ages.[1]

V.

Another important branch of the same investigation remained to be followed up—namely, an analysis of the fossil fauna of the ossiferous caverns of Great Britain, conducted upon the same plan; and as the reagitation of the question of the remote antiquity of the human race in Europe, and the establishment of the evidence, to the conviction of geologists, arose out of it as immediate results, I must be pardoned for entering in some detail upon the history of the question.

Bone caves occur generally over Europe, but they are especially abundant in England, Germany, France, Italy, and Sicily. The fossil remains found in them had been carefully studied by Cuvier and by various other palæontologists, in different countries, since his time. The theory of the process of their filling up, with their organic contents, had been keenly discussed by Dr. Buckland and by Constant Prévost, who entertained diametrically opposed views upon the question. A great number of other cryptological observers, after them, took a share in the discussion; and an excellent epitome of the whole case was brought out by Desnoyers, in a monograph which appeared in 1849. But at the period to which I refer, 1856, the views of geologists, respecting the epoch when the fossil quadrupeds whose remains occur in them lived and were there introduced, were in a very unsettled state. Desnoyers left the question as he found it, undetermined. For the prevalent opinions held in England, I shall refer to standard systematic works, by two eminent living authorities, Professor John Phillips and Sir Charles Lyell. The former, to whom we are indebted for the systematic use of the terms PREGLACIAL and POSTGLACIAL, which define with such precision the Quaternary deposits *before* and *after* the submergence of the Glacial period, in his 'Manual of Geology,' published in 1855, expresses his opinion, in the clearest language: 'To the Preglacial era belong, we think, the greater number of ossiferous caves and fissures, containing Elephant, Hippopotamus, Hyæna, and other extinct species of animals.' (*Op. cit.* p. 411.) Sir Charles Lyell, in the fifth edition of his 'Manual,' published in 1855, takes a similar view, and classes the caves in Chap. xiii. among the newer Pliocene formations, *below* or

[1] See *antea*, p 239.—[ED.]

anterior to the Boulder-clay of the glacial submergence. In the supplement to the fifth edition, published in 1859, the following is the only passage having reference to the age of the caverns: 'To what part of the Pliocene period the cave animals of Great Britain should be referred is still a vexed question. There seems, however, no reason at present to suppose any of them more ancient than the Norwich Crag; and many caves may have remained open during the Glacial and Post-Glacial eras, while the fauna was gradually changing, so that the remains found in them may not always belong to strictly contemporary quadrupeds.' (*Op. cit.* p. 8.) No language could have been used better calculated to express the conjectural and hesitating views then entertained respecting the caves: they might be of any age before the Glacial period or after it. The late Joshua Trimmer, an experienced observer of weight on all that concerns Quaternary deposits, expressed the following opinion in his 'Generalizations respecting the Norfolk Erratics': 'With regard to Mammalian remains, I believe that we have two Elephantine groups, one *preceding* the submergence of the erratic period, and the other inhabiting the country *at the close* of the period of elevation. To the *former* are to be referred the Mammalian Crag, and the remains of the bone-caverns in general.'[1]

The determination of the Cave fauna was, in some respects, in a similarly backward state. Not a suspicion even was entertained, so far as published evidence shows, that any other Elephant than the Mammoth, or Rhinoceros other than the tichorhine species, had left their remains in the caverns, although *Elephas antiquus*, Falc., and *Rhinoceros hemitœchus*, Falc., were subsequently discovered in them in abundance, these two species, along with *Hippopotamus major*, constituting at the present time the criteria by which British geologists test the more or less remote antiquity of the works of man occurring in Drift deposits.[2]

In May 1860 I communicated to the Geological Society a memoir 'On the Gower Caves,' which was read at the meetings held on the 31st May and 13th June.[3] The caverns of the Gower peninsula, Paviland being one of them, are very numerous, and correspondingly rich in fossil remains; while in other respects they present favourable conditions for determining the question, then unsettled, such as are nowhere else to be found in Great Britain. Their floor in many cases is covered with marine deposits, containing shells,

[1] Quarterly Journal Geol. Society, 1850, vol. vii. p. 25.

[2] *Vide* Sir C. Lyell's 'Antiquity of Man,' *passim*.

[3] See *antea*, p. 498.—[Ed.]

above which the ossiferous strata are piled in beds alternating with numerous thick layers of stalagmite; they are in close juxtaposition with a boldly-developed raised sea-beach, first observed and investigated by Mr. Prestwich; and on the high land of Gower, which backs the caves, the same able observer detected remains of Drift deposit, indicative of the submergence of the Glacial period. Availing myself of the rich and unrivalled collections formed by my friend Lieut.-Colonel Wood, of Stout Hall, during many years of patient inquiry, and following up their indications, in further researches conjointly with him, I endeavoured to trace the successive appearance of the newer and newer forms, through the magnificent sections furnished by the Gower caves, regarded as a series, until we were conducted to the period when man presented himself as a tenant of the caves. Some of the Gower caverns, such as 'Minchin Hole,' were of an amplitude comparable to that of a cathedral, with an open-vaulted mouth. Below they were strewed with sea-sand and shells, above which ochreous cave-earth, crammed with bones, and layers of stalagmite were disposed in numerous successive layers. These alternations implied repeated changes of the physical conditions which held in their interiors, dependent probably on the shocks involved in movements of upheaval or depression, by which long-established lines of subterraneous drainage were for a time intercepted and then reproduced; the periods of action and repose being respectively indicated by the layers of ochreous loam and stalagmite. Had the coast line in which the caves are chiefly situated ever been submerged, after the osseous remains were introduced, under the sea of the Glacial period, it was impossible that marine deposits should not have been introduced somewhere between these alternations, significant of the event. The cave called 'Bosco's Den,' placed at a higher level, presented an enormous depth of ochreous cave-loam, impacted with horns and bones of the Reindeer, and overlaid at the top by a thick cake of stalagmite, upon the surface of which a bed of peat was accumulated. In no one of these instances was there the slightest indication of Drift or Boulder-clay above the ossiferous strata, ancient or modern. After balancing the various classes of evidence, and instituting a comparison of the Gower caves with those of the other cave districts of England in particular, and of Europe in general, the following conclusions were announced in the memoir above referred to:—

'1. That the Gower caves have probably been filled up with their mammalian remains since the deposition of the "Boulder-clay."

'2. That there are no mammalian remains found elsewhere in the

ossiferous caves in England and Wales referable to a fauna of a more ancient geological date.

'3. That *Elephas* (*Loxodon*) *meridionalis* and *Rhinoceros Etruscus*, which occur in, and are characteristic of, the "Submarine Forest-bed" that immediately underlies the Boulder-clay on the Norfolk coast, have nowhere been met with in the British caverns.

'4. That *Elephas antiquus* with *Rhinoceros hemitœchus* and *E. primigenius* with *Rh. tichorhinus*, though respectively characterizing the earlier and later portions of one period, were probably contemporary animals; and that they certainly were companions of the Cave-Bears, Cave-Lions, Cave-Hyænas, &c., and of some at least of the existing Mammalia.'

The inferences arrived at were at least definite, in indicating the fauna of the ossiferous caves of England to be Post-Glacial. They were at the time unexpected, and, when communicated, they encountered lively opposition in discussion as being opposed to the views then commonly entertained regarding the age of the fauna of the caves, and of the Quaternary deposits of the river valleys which yield remains of the same Mammalia in corresponding association. But their soundness has not been impugned since, and the subsequent discovery by Mr. Prestwich, at Sudbury and Bedford, of an analogous deposit containing bones of *Hippopotamus* and other mammalian species characteristic of the Thames Valley beds, superimposed upon the glacial drift, proved that the brick-earths and gravels of the Thames Valley were Post-Glacial; while my own researches upon their mammalian remains showed that their fauna was identical with that of the caves, which I had inferred from another class of evidence to be Post-Glacial. Mr. Prestwich had long and consistently held the opinion that the Grays Thurrock and Ilford beds were later than the Boulder-clay;[1] but it was not until after many years of ineffectual search that the Sudbury and Bedford sections enabled him to prove the case stratigraphically. The conclusions above cited, regarding the Gower caves—exclusive of the second, which is irrelevant—are at the present time applicable categorically to the Post-Glacial deposits of the Valley of the Thames, in so far as their age and mammalian fauna are concerned.

VI.

These cave researches extended over several years, and involved an examination of every cave district in England, besides numerous caves on the Continent. They demanded also the careful study of every accessible collection of

[1] Mr. Joshua Trimmer held the same view, but coupled with it the erroneous opinion that the same fauna in the caves was preglacial. (*Supra*, p. 583.)

fossil bones in England, public or private, bearing on the question. In the spring of 1858, while thus occupied, I made an excursion to the cave districts of the Mendip hills, Devonshire, and South Wales, in company with my friend the Rev. Robert Everest, with whom I have been associated in similar objects, off and on, during thirty years. At Torquay, when examining 'Kent's Hole,' we heard of the recent discovery of a new cave near Brixham, where we proceeded on the 17th April, after receiving from Mr. Pengelly every information that he could give us for our guidance. The cave was then intact. We examined it, and made overtures to the owner about an arrangement to explore it. On my return to London, being then on its Council, I addressed a letter regarding the Brixham Cave to the Secretary of the Geological Society, dated the 10th May, 1858.[1] The following is a condensed abstract of its contents :—

The decline of interest among geologists in the cave question since the time of the 'Reliquiæ Diluvianæ' of Buckland —the backward and unsettled state of opinion respecting the age of the ossiferous caverns—the erroneous views commonly entertained on the subject in the cave districts, and the evil effects resulting therefrom—the imperfect manner in which cave explorations had hitherto been conducted in most instances in England—the huddling together in collections of the fossil specimens without reference to the order in which they occurred—the dispersion of some of the most important and classical of English collections—the necessity of retrieving past mischief and past errors, by the carefully organized exploration of a virgin cave—a description of the newly-discovered cave at Brixham as it then stood, and the favourable opportunity which it offered. The necessity was urged 'of a combined effort among geologists to organize operations for having it satisfactorily explored, before mischief is done by untutored zeal and desultory work.'

In order to give weight to the appeal, I communicated some of the new and unpublished results, to which my inquiry so far had led :—

1. The detection in certain of the caves of the remains of a species of *Rhinoceros*, equally distinct from the tichorhine species of Siberia, and of the Glacial period generally; and distinct also from the leptorhine *Rhinoceros* of Cuvier, of the Sub-Apennine 'Elephant-bed' and lacustrine deposits of the Norfolk coast. This is the species now known as *Rhinoceros hemitœchus*, Falc.

2. Abundant evidence in all the cave districts of two extinct species of Elephant; viz. *E. primigenius* of the Glacial

[1] See *antea*, p. 487 — [Ed.]

period, and *E. antiquus* of the Sub-Apennine period (the Astesan and the 'Norwich Crag'), the former commonly associated in the English caves with *Rhinoceros tichorhinus*, the latter with *Rhinoceros hemitœchus*.

3. The absence of *Elephas meridionalis* and the form called *E. priscus* (since abandoned[1]) in all the cave collections; and the association in one of them of *Elephas antiquus*, *Rhinoceros hemitœchus*, and *Hippopotamus major*, without the admixture of other species of the same genera.

4. The absence from all the caves of the *Rhinoceros leptorhinus* of Cuvier, as I regarded the species to be limited.

Other results were communicated which need not be cited here. The letter concluded by calling attention to an important speculation recently advanced by M. Lartet, that the Mammalian fauna of the Glacial period in Europe was made up of two distinct geographical elements: the one a northern division, pushed southwards from Siberia; the other a southern division, projected northwards from Mauritania. The proposed exploration might throw light on this question also.

The letter dated the 10th was on May 12th submitted to the Council of the Geological Society, by whom the case was warmly entertained; a recommendatory resolution was passed, and entrusted to the able advocacy of the veteran Mr. Horner, who brought it before the Council of the Royal Society on May 13; and that learned body the same day gave a grant of 100*l*. towards the object. Miss Burdett Coutts, whose expansive munificence is alive to every object affecting the improvement, material, moral, or intellectual, of her country, contributed a large donation. So earnest was the co-operation of men of science on this occasion, that in little more than twenty-four hours after the case was brought forward the means were provided for carrying the design into execution. A committee at my suggestion was appointed in London; Mr. Prestwich took charge of the financial and business details; I was intrusted with laying down the plan and giving the instructions upon which the exploration was to be conducted; a local committee was formed at Torquay, but for unity of action the responsible direction of the explorations speedily centred in Mr. Pengelly, of whom I am bound to say that never, I believe, was an inquiry of the kind carried out with more conscientious care or greater ability than by him. The deposits were taken up horizontally, like sheets of paper; every object met with had its position fixed in reference to definite points, vertically and horizontally; the collections of each day were

[1] See *antea*, p 251, *note* 1.—[Ed.]

labelled and set apart, and a diary of the work kept. Excellent data of the most trustworthy character were thus obtained. When sufficient progress had been made, Professor Ramsay, now President of the Geological Society, and myself proceeded early in September 1858, to examine and report on the cave. The fossil remains were identified by me, and the flint flake-implements determined on the spot by reference to the outline figures of Abbeville specimens in M. Boucher de Perthes' 'Antiquités Celtiques;' Professor Ramsay made a rough sketch plan; Mr. Pengelly supplied all the data of the workings; and a joint report was drawn up on September 9, in which it was stated that human industrial remains occurred in the Brixham Cave, *indiscriminately* mixed with remains of *Rhinoceros*, *Hyæna*, and other extinct forms, in the undisturbed ochreous Cave-earth; and that we failed to discover that they had been introduced into the cavern by different agencies, or that they were of a different age. That report was submitted to the London Committee, and adopted on September 9, 1858. It was then forwarded to the Royal Society, which upon the strength of it gave another grant of 100*l.* to prosecute the exploration. From that period dates the wane of scepticism among scientific men in England, respecting the geological evidence of the antiquity of man as a cotemporary of the external fauna of the Post-Glacial period. The humble share which I claim to have had in the case is, that the exploration of the Brixham Cave was led up to by the general cave inquiry above referred to; that the existence of the cave was brought to the knowledge of men of science by me; that its exploration for a specific object was taken up at my suggestion, and carried out on the plan laid down by me, with my constant co-operation or advice throughout as the final referee; that the fossil remains and other objects discovered in it were identified or determined by me; and that the report in which the important conclusions were announced was drawn up on those determinations.[1] The only other point requiring notice is, that while the excavations were in progress, Mr. Bristow, F.R.S., was deputed from the staff of the Geological Survey, on the requisition of the London Committee, to make a careful plan of the cavern, which he accompanied with a descriptive report, and Mr. Prestwich was requested to look into some of the general physical phenomena.

[1] Professor Phillips, then President of the Geological Society, Professor Ramsay, now President, Mr. Prestwich, Mr. Pengelly, and Dr. John Percy, F.R.S., all members of the committee, can confirm the statement; as do also the documents in the records of the Geological Society.

VII.

To revert to the general cave investigation. It has been already mentioned that the Gower caverns presented conditions favourable for determining some of the doubtful questions, such as are nowhere else to be found in England, from the fact of their floors being covered by marine deposits containing shells. The only corresponding case in Europe then generally known was the celebrated ossiferous cavern of San Ciro, near Palermo, described by the Abbate Scinà, Hoffmann, and Turnbull-Christie, which I determined to examine before making public the results arrived at regarding the geological age of the English caves. The Gower caves had also yielded in considerable variety and abundance relics of man, both osseous and industrial, the latter consisting of wrought flints, bone-weapons or implements, and ivory ornaments. These had been discovered chiefly in the Paviland Cave, above or below the skeleton of the 'Red Lady of Gower,' celebrated through the researches of Dr. Buckland. I became early familiar with every form in which they occur, in the original collections preserved in Gower, and formed at the time of the exploration. My fellow-labourer and friend, Colonel Wood, had amassed a considerable collection of wrought flints and bone-weapons, a part of which were subsequently the product of our repeated joint visits to the cavern. He had also discovered human bones in 'Spritsail-Tor' Cave, and in the ossiferous fissure of 'Mewslade.' I was acquainted, from observations made on the spot, with the extinct mammalia with which they were associated, and with the circumstances under which they occurred. After the arrangements for carrying on the exploration of the Brixham Cave were completed I left England for Sicily, at the end of October 1858, taking Montpellier in my route, in order to study the cave collections of the south of France, and the human remains investigated by Christol, Tournal, Marcel de Serres, &c., which had been the subject of such contested discussion thirty years before. I then proceeded to Nice, to examine the brecciated mass of human bones discovered near St. Hospice, and thence to the 'Baussi-Raussi' or Rocco Rosso caverns, near Mentone, which have yielded such abundant relics of long-continued human occupation, upon the exploration of M. François Forel. On reaching Palermo I found that the contents of the San Ciro cavern had been so disturbed during the operation of the Government Commission, under the direction of Abbate Scinà in 1830, that not a trace of the marine deposit, originally found upon the floor, could be detected, in consequence of the materials having been thrown up in a confused mass of talus, extending backwards to near

the roof of the grotto cavern. But the protracted submergence of the wide fissure under the sea was distinctly proved by the polished eastern wall, and by a band thickly drilled by Pholad-borings. It thus became necessary to search elsewhere along the coast, and after examining the other ossiferous caverns in the immediate vicinity of Palermo, I discovered the 'Grotta di Maccagnone,' until then unknown to the Sicilians.[1] An account of this remarkable ossiferous cave, dated Palermo, March 21, 1859, and extracted from a letter addressed to Sir Charles Lyell, was communicated to the Geological Society on the 4th of May; and on the 22nd June a more detailed description was delivered to the same body, when the collection of specimens illustrative of the history of the cavern was exhibited.[2] They excited lively interest, from the striking manner in which they confirmed the results arrived at by the exploration of the Brixham Cave. The 'Grotta di Maccagnone' is an open rock-chamber in Hippurite limestone, which had formerly been filled up to the roof with alluvial matters and fossil bones, probably introduced from above by rills through refts and crevices in the fissured rock-strata. That the action had been of a tranquil nature was clearly indicated by the presence of large fragile Helicine shells, mingled in perfect integrity with the other materials in the bone-breccia. The long-continued operation of stalagmitic drip had by infiltration solidified the layer immediately in contact with the roof into a thick mass of hard breccia, in which large quantities were discovered of broken siliceous stone-knives, composed of chalcedony, and of the ordinary flake-pattern, presented by the modern obsidian razor-knives of Mexico. These were intermixed with entire and comminuted shells, bone splinters, teeth of horses and ruminants, pieces of burnt clay, bits of charcoal, &c., clearly indicative of the presence of man. In another part of the same roof-breccia abundant remains were discovered of the coprolite of a Hyæna, which has long been extinct in Europe; and on the alluvial floor, below the flint-knife breccia, the molar tooth of an Elephant was found, of

[1] In my memoir on the Grotta di Maccagnone, I premised the account of it with a description of the physical and geological characters of that portion of the north coast of Sicily between 'Termini on the east and Trapani on the west,' in which 'the ossiferous caves abound.' The author of the 'Antiquity of Man' (*op. cit.* p. 174) asserts that 'geologists have long been familiar with the fact, that on the northern coast of Sicily, *between Termini on the east and Trapani on the west*, there are many caves containing the bones of extinct animals.' Sir Charles Lyell has not shown in what geological works the asserted familiar knowledge is to be found before the appearance of the memoir above referred to. The existence close to Palermo of the ossiferous caves of San Ciro, Belliemi, and Ben Fratelli was of course well known.

[2] See *antea*, p. 543.—[Ed.]

a species which, also, has been long extinct in Europe. The inferences drawn from the whole case were, that the cavern, originally full of alluvial matter, had been cleared out by physical changes involved in upheavement, or other alteration of level, with the exception of the solidified portion immediately in contact with the ceiling. Following up the investigation afterwards, strong presumptive proof came out that the date of man's occupation, in the savage state, of Sicily went back to a period extremely remote, as compared with accepted chronology, Biblical or profane, when the Mediterranean was bridged over by land connecting Sicily with Africa as a promontory of that continent. The evidence upon this head will be considered in a subsequent chapter.[1] Soon after the date of this communication another branch of the evidence, proving the remote antiquity of the human race, the agitation of which arose out of these cave investigations, was launched into discussion among geologists. To this part of the subject I shall now briefly refer.

VIII.

In September of 1856 I made the acquaintance of my distinguished friend M. Boucher de Perthes, on the introduction of M. Desnoyers at Paris, when he presented to me the earlier volume of his 'Antiquités Celtiques,' &c., with which I thus became acquainted for the first time. I was then fresh from my examination of the Indian fossil remains of the Valley of the Jumna; and the antiquity of the human race being a subject of interest to both, we conversed freely about it, each from a different point of view. M. de Perthes invited me to visit Abbeville, in order to examine his antediluvian collection, fossil and archæological, gleaned from the Valley of the Somme. This I was unable to accomplish then, but I reserved it for a future occasion.

In October 1858, having determined to proceed to Sicily, I arranged by correspondence with M. Boucher de Perthes, to visit Abbeville on my journey through France. I was at the time in constant communication with Mr. Prestwich about the proofs of the antiquity of the human race yielded by the Brixham Cave, in which he took a lively interest; and I engaged to communicate to him the opinions at which I should arrive, after my examination of the Abbeville collection. M. de Perthes gave me the freest access to his materials, with unreserved explanation of all the facts connected with the case that had come under his observation; and having considered his Menchecourt Section, taken with such scrupulous care,[2] and identified the molars of *Elephas*

[1] See *antea*, pp. 552, 559.—[Ed.]

[2] The section in question, 'Antiquités Celtiques,' tome i. p. 234, was made by M. Ravin.

primigenius, which he had exhumed with his own hands deep in that section, along with flint-weapons, presenting the same character as some of those found in the Brixham Cave, I arrived at the conviction that they were of contemporaneous age, although I was not prepared to go along with M. de Perthes in all his inferences regarding the symbolical hieroglyphics, and an industrial interpretation of the various other objects which he had met with. The results of my impressions were communicated to Mr. Prestwich, in a letter dated Abbeville, November 1858, of which the following is a transcript:—

[Copy.]

Abbeville, Nov. 1, 1858.

My dear Prestwich,—As the weather continued fine, I came on here to see Boucher de Perthes' collection. I advised him of my intention from London, and my note luckily found him in the neighbourhood. He good-naturedly came in to receive me, and I have been richly rewarded. His collection of wrought flint-implements, and of the objects of every description associated with them, far exceeds anything I expected to have seen, especially from a single locality. He has made great additions, since the publication of his first volume, in the second, which I have now by me. He showed me 'flint' hatchets which *he had dug up* with his own hands mixed *indiscriminately* with the molars of *Elephas primigenius*. I examined and identified plates of the molars and the flint-objects which were got along with them. Abbeville is an out-of-the-way place, very little visited, and the French savants who meet him in Paris laugh at Monsieur de Perthes and his researches. But after devoting the greater part of a day to his vast collection, I am perfectly satisfied that there is a great deal of fair presumptive evidence in favour of many of his speculations regarding the remote antiquity of these industrial objects, and their association with animals now extinct. M. Boucher's hotel is, from ground-floor to garret, a continued museum filled with pictures, mediæval art, and Gaulish antiquities, including antediluvian fl nt-knives, fossil-bones, &c. If, during next summer, you should happen to be paying a visit to France, let me strongly recommend you to come to Abbeville. I am sure you would be richly rewarded. You are the only English geologist I know who would go into the subject *con amore*. I am satisfied that English geologists are much behind the indications of the materials now in existence relative to this walk of *Post-Glacial* geology, and you are the man to bring up the lee-way.

I saw no flint specimens in his collection so completely whitened through and through, as our flint-knives (*i.e.* from the Brixham Cave), and nothing resembling the mysterious hatchet which I made up of the two pieces. What I have seen gives me still greater impulse to persevere in our Brixham explorations.—Yours very truly,

H. Falconer.

Joseph Prestwich, Esq.

The interest excited by this note was further stimulated by the accounts which reached England, in April 1859, of the results of the 'Maccagnone' exploration; and Mr.

Prestwich, joined by Mr. John Evans, proceeded to Abbeville during the Easter recess, at the end of the same month. The evidence yielded by the Valley of the Somme was gone into with the scrupulous care and severe and exhaustive analysis which are characteristic of Mr. Prestwich's researches. The conclusions to which he was conducted were communicated to the Royal Society on the 12th May, 1859, in his celebrated memoir, read on the 26th May, and published in the 'Philosophical Transactions' of 1860, which, in addition to researches made in the Valley of the Somme, contained an account of similar phenomena presented by the Valley of the Waveney, near Hoxne, in Suffolk. Mr. Evans communicated to the Society of Antiquaries a memoir on the character and geological position of the 'Flint Implements in the Drift,' which appeared in the 'Archæologia' for 1860. The results arrived at by Mr. Prestwich were expressed as follows:—

'1st. That the flint-implements are the result of design and the work of man.

'2ndly. That they are found in beds of gravel, sand, and clay, which have never been artificially disturbed.

'3rdly. That they occur associated with the remains of land, freshwater, and marine Testacea, of species now living, and most of them still common in the same neighbourhood, and also with the remains of various Mammalia—a few of species now living, but more of extinct forms.

'4thly. That the period at which their entombment took place was subsequent to the Boulder-clay period, and to that extent Post-Glacial; and also that it was among the latest in geological time—one apparently immediately anterior to the surface assuming its present form, so far as it regards some of the minor features.'

The European reputation of Mr. Prestwich stamped these conclusions as well-weighed and established facts in science. What has since followed has been the confirmation of the results successively arrived at by Boucher de Perthes, Rigollot, and Prestwich, the last having relieved them from the trammels of Diluvian agency. Geologists, French, English, and Continental generally flocked to Amiens and Abbeville, some for a time maintaining cautious doubts, but the great majority convinced by the evidence. The case was fully proved, when some eminent British geologists tendered their acceptance of the geological evidence of the antiquity of man, derived from his embedded works: Sir Charles Lyell, at the Aberdeen meeting of the British Association in Sept. 1859; followed a year later by Sir Roderick Murchison at the meeting of the same body held at Oxford in Sept. 1860. The public mind, led in its convictions by the favoured few whom

it elected to follow, was craving for accessible information on the subject; and a well-considered digest of the evidence of the case, in all its bearings, was the only thing wanting to secure for it the accepted belief of mankind.

To recapitulate, I have endeavoured to show in the preceding remarks, that as far back as 1836 I was engaged on questions concerning the remote antiquity of man in that part of the globe which has been generally believed to have been the cradle of the human race; that, in 1844, I had put forward speculations on the subject, founded upon palæontological grounds; that in 1854, by published evidence, I was occupied with the same subject; that since then I have been concerned with researches which have borne directly or indirectly upon the same point; and that the cave inquiry which I undertook led immediately to the re-investigation of the whole evidence respecting the antiquity of man by geologists.

My aim in the above narrative has been to satisfy my readers that, as a humble labourer in the field, I have not been unfamiliar nor unconnected with the subject of the present work. But in reading it over, I experience the '*surgit aliquid amari*,' in the feeling that the claims of the individual float too prominently on the surface throughout. This, doubtless, is an unseemly trait, which bears with it its own corrective in the impression which it is calculated to leave behind. There are occasions, however, in which the retired and unobtrusive student is justified in speaking out; and this has appeared to me to be one. In support of all that I have stated I have cited either published or authentic documents. The important record of history sooner or later apportions to each his due; while the true reward that the inquirer into the truths of nature has lies in the rational gratification which the pursuit carries inseparably with it, and in the satisfaction that in his day and generation he has contributed his mite to the advancement of that natural knowledge with which the destiny of the human race is so intimately bound up. After a few years the little he may have done may be absorbed in a single line or sentence of the great code, or it may be fused with it, '*in succum et sanguinem*,' without a trace even of the source from which it emanated. But while the observer 'frets his brief existence on the stage,' he should take care, in the abstract interest of truth, apart from personal considerations, that what he may have done shall not be passed over by default of his own appearance to record it. This is the only apology which I have to offer for the unseemly trait alluded to. Much of what has been stated may appear to be beside the question; but there is no royal road to the extension of

natural knowledge. It is only to be accomplished by sustained and patient labour. The generalized results to which the tedious details lead, and which alone go to increase the common stock, once arrived at are readily dressed up in a fitting garb, and when skilfully combined along with cognate materials, they produce the same pleasurable effect which is yielded by the contemplation of exquisite forms in fragile porcelain, artistically disposed in an elegant cabinet. But the intelligent observer will not rest satisfied with the mere æsthetic effect of the *ensemble*; he will be curious to know something of the nature of the crude material, of the processes by which they have been elaborated, of the hands which have moulded them into shape or laid on the harmonious colours, and of the *ateliers* which have sent them forth as finished works. And so the reflecting reader, whose interest has been enlisted in some newly-explored region, will not be indifferent to a narrative of the devious routes and toilsome journeys, by which the travellers themselves have acquired the knowledge which now engages his attention. In this spirit, I trust they will regard the preceding remarks as an excusable vindication of the share that Mr. Prestwich and myself have had, first, in the investigation of the Quaternary deposits and ossiferous caves, which have led up to that of the localities in which human relics of great antiquity occur; second, in the investigation of the relics themselves, and the conditions under which they are found.

FIG 9.

XXV. ON THE EVIDENCE IN THE CASE OF THE CONTROVERTED HUMAN JAW AND FLINT-IMPLEMENTS OF MOULIN-QUIGNON.[1]

THE published *procès-verbaux* embody the leading points of the evidence brought out during the investigation by the late Conference,[2] held in Paris and at Abbeville, on the cir-

[1] The MS. of this essay was found among Dr. Falconer's papers.—[ED.]

It may be useful to give here a brief *resumé* of the circumstances which led to the meeting of the Conference. Fashioned flint-weapons, unquestionably of very remote antiquity and as certain proofs of human agency as the watch in the illustration of Paley, had turned up in surprising abundance in the old gravel-beds of Amiens and Abbeville, but not a vestige of the bones of the men who shaped them into form. Why it should be so was a mystery, for human bones are as enduring as those of deer, horse, sheep, or oxen, and fossil bones of extinct animals were not unfrequent in the Somme Valley deposits. At last it was thought that the objects so long sought for in vain had been discovered. To pass over minor incidents, on March 23, 1863, a *terrassier* brought to M. de Perthes, from the bottom of the gravel-pit of Moulin-Quignon, two flint *haches* and a fragment of bone, which, on detaching the dark matrix enveloping it, he found to be a human tooth. On March 28, M. de Perthes was summoned to the same gravel-pit (described by Mr. Prestwich in his memoir in the 'Philosophical Transactions') to examine *in situ* what appeared to be a portion of bone projecting from the section, close to its base. The specimen was carefully detached with his own hands by M. de Perthes, and proved to be the entire half of an adult human lower jaw, quite perfect, and containing one back tooth—namely, the penultimate, or last but one. The sockets of the other teeth were all present, and filled with matrix, with the exception of the antepenultimate, the socket of which was effaced, the tooth having been lost during life. The solitary molar present was hollow from *caries*, and this hollow was also filled with the matrix.

The deposit from which the jaw was extracted was the 'black seam flinty gravel,' so called from its intensely dark (blueish-black) colour, arising from oxides of iron and manganese. It rested immediately upon the chalk, and belonged to what Mr. Prestwich calls the 'high level' series, being the oldest of the Somme Valley beds. A thin layer of black mangano-ferruginous clayey matter was interposed between the chalk and the gravel. If the jaw had proved to be an authentic fossil, and had come out of the alleged position, it indicated the existence of man, by an actual bone, at a period of extremely remote antiquity. A single detached human molar was found at the same time, corresponding exactly in appearance and in the matrix with which it was covered; and, to complete the case, a flint hatchet, covered with black matrix, was extracted from the same spot by M. Oswald Dimpre, who accompanied M. de Perthes. The details were all given by M. de Perthes in the 'Abbevillois' of April 9, 1863, and in a note communicated to the Academy of Sciences on April 20.

Mr. Prestwich, Mr. Evans, and Dr. Falconer were in France at the time, and hearing of the asserted discovery, they determined to visit Abbeville. The two former proceeded there on April 13, when their suspicions were instantly aroused. They pronounced the *haches* said to have been yielded by the '*couche noire*' to be modern fabrications. Dr. Falconer followed a day later, when they had left, and also got several *haches* from the 'black-seam gravel,' which, upon closely examining them upon his return

cumstances attending the alleged discovery of a human jaw in the gravel deposits of Moulin-Quignon. The fact was first announced by M. Boucher de Perthes in the 'Abbevillois' of

to London, he considered to be spurious. Having been obligingly permitted by M. de Perthes to examine the jaw, he was struck with the unusual combination of peculiar anatomical characters which it presented, and was thus led to the impression that it was of fossil antiquity. That impression he communicated on the 14th to Dr. Carpenter, and on the 15th to M. de Quatrefages, at Abbeville, but subject to the reserve of a more detailed study of the materials, and on the 15th he wrote to the same effect to his friend M. Lartet, to whom the jaw was consigned in Paris.

On April 16 Dr. Carpenter communicated a short paper to the Royal Society, supporting the authenticity of the discovery; and during the debate, Dr. Falconer, in the absence of Dr. Carpenter and himself, was unauthorizedly cited as entertaining the same opinion. On April 20, M. de Quatrefages communicated to the 'Academy of Sciences' a note by M. Boucher de Perthes, followed by descriptive remarks by himself, conveying the high authority of his opinion in favour of the jaw being a true fossil of geological antiquity. On April 18 Dr. Falconer, immediately after his return to London, commenced the deliberate scrutiny of the materials which he had brought with him from Abbeville, and on the 21st, in conjunction with, or aided by, Mr. John Evans, Mr. Prestwich, Mr. Busk, and Mr. Tomes, he arrived at results opposed to the authenticity alike of the 'detached molar' of the jaw, and of the flint *haches*. That day, without the delay of a post, he communicated his suspicions to M. Lartet, requesting him to make them, and the grounds upon which they were founded, known to M. de Quatrefages. But the latter had already given in his affirmative memoir to the 'Institut' on the previous day (20th), followed on April 27 and May 4 by successive notes in the same sense. On April 25 a letter by Dr. Falconer, written before he was aware of M. de Quatrefages' first communication, appeared in the 'Times,' questioning the authenticity of the 'jaw' and of the *haches*. Men of science in France and England were thus suddenly placed at direct issue on a grave and important point of great general interest. But, happily, from the frankness and rapidity of the communications interchanged, there existed the most cordial relations, and the conviction of loyalty and good faith on both sides. The French *savants*, the more they went into the case, were the more convinced of the soundness of their conclusions; while their English opponents, the more they weighed the evidence before them, were the more strengthened in their doubts. As a wordy discussion would but have wasted time and must have been protracted, and as a personal conference held out the best prospect of a speedy settlement of the question, a '*réunion*' of men of science, to be held at Paris, was proposed by the French *savants*.

The English deputation, consisting of Dr. Falconer, Dr. Carpenter, and Prof. Busk, reached Paris on May 9, and immediately proceeded to business, being joined on the following day by Mr. Prestwich. The French members consisted of M. de Quatrefages, Member of the Institute; M. Lartet, Member of the Geological Society of France and Foreign Member of the Geological Society of London; M. Delesse, Professor of Geology to the École Normale, Paris; and M. Desnoyers, Member of the Institute. The following *savants* also took a share in the proceedings throughout, and afforded the utmost aid in the investigation, viz.:—M. L'Abbé Bourgeois, M. A. Gaudry, and M. Alphonse Milne-Edwards. At the request of the English members, M. Milne-Edwards, Member of the Institute, and the eminent zoologist, courteously agreed to preside over the Conference.

The *procès-verbaux* of this Conference, which extended over five days, were printed in detail in the 'Natural History Review,' for July, 1863, with an introduction and appended notes, by Dr. Falconer, Mr. Busk, and Dr. Carpenter. The conclusions arrived at by the Conference are embodied in Dr. Falconer's essay, which is now for the first time published.

The above particulars are derived from the introduction to the *procès-verbaux* above referred to, and from two letters by Dr. Falconer which appeared in the 'Times' newspaper for April 25 and May 21, 1863.—[ED.]

April 9th. On April 16th it was communicated to the Royal Society, and on the 19th to the Academy of Sciences. On April 25th the authenticity of the jaw and *haches* was controverted in the 'Times.' On May 9th the Conference opened at Paris, and it closed at Abbeville on the 13th. On May 18th M. Milne-Edwards and M. de Quatrefages severally communicated notes to the Academy of Sciences, on the results at which the Conference had arrived. The ink with which the convention was signed was hardly dry when M. de Beaumont struck at the whole fabric a blow, 'qui semble enlever toute valeur scientifique à la mâchoire dont on s'est tant occupé.' At that meeting of the Academy, this eminent geological authority refused to admit that the Moulin-Quignon gravels were older than the modern period. He referred them to the age of the Peat-beds of the Valley of the Somme, in which human skeletons with implements of stone and iron abound; and at the next following meeting of the Academy, when he resumed the subject, he stated that a corresponding peat-bed covered the remains of an ancient Roman way in the *Département du Nord*.

That 'le cercle de la discussion relative au gisement de Moulin-Quignon est peut-être bien loin d'être épuisé,' is clear from the next incident in the order of events. At the meeting of the Academy held on May 25, M. Hébert, in a review of the opinions advanced by M. de Beaumont, assigned a different geological position to these beds, which he removes from the ancient Quaternary deposits of the Valley of the Somme, such as Menchecourt and St. Acheul, placing them two stages even above the *Loess*, but below the Peat-bed alluvia, while Mr. Prestwich, in a recent communication to the Geological Society, after a fresh survey of the field, maintains his original opinion that the Moulin-Quignon beds belong to the 'high level' gravels, or oldest Quaternary deposits of the Somme, formed immediately after the excavation of the valley began. We have thus three different phases of opinion by competent authorities on the geological age of the beds, and it is difficult to conceive the divergency being carried further, or of more being entertained, respecting the case.

The contested *haches* of the *couche noire* have not fared better. Accepted at last by the great majority of the Conference as authentic, they have been severely assailed in a communication addressed to the 'Athenæum' on June 2, by Mr. John Evans, who, unable to be present at the Conference, to which he was invited, paid a fresh visit to Abbeville at the end of last month, in order to reinvestigate the circumstances of that part of the case. He contends that the sus-

pected *haches* are modern fabrications, and thinks that he has detected the proof of their having been introduced into the gravel section. After detailing the results of his observation he adds: 'There remains therefore not the slightest doubt on my mind that a fraud, and a most ingenious and successful one, has been practised by some of the Abbeville terrassiers.'

Nor has the celebrated jaw itself had immunity from discussion conferred upon it by the verdict of the Conference. An eminent French Anthropologist, M. Pruner-Bey, well known for his familiarity with the characters which distinguish the races of mankind, has submitted the jaw to examination in the aspect of its natural history peculiarities, and arrived at the opinion that, 'La *mâchoire* de Moulin-Quignon appartenait à un individu brachycéphale, de petite taille, de l'âge de pierre.' He found that it corresponded with a Swiss lower jaw of the brachycephalous type, of the age of iron in every respect, except that the coronoid process in the latter was more elongated. M. Pruner-Bey does not state to what division of the 'Stone-age' the jaw is, in his opinion, referable; and his remarks do not necessarily remove it from the position assigned to it by the verdict of the Conference; but they are suggestive of further inquiry as to the direction of its affinities.

It is evident, therefore, that to the conviction of men of science, the labours of the Conference have not definitively settled any one of the moot points which came before it. But the mass of evidence which it collected and the conflict of opinion which it elicited will doubtless assist materially in conducting to a final judgment hereafter. The case throughout maintained a perplexed and contradictory character, not to be surpassed probably by any *cause célèbre* on record.

The evidence was of two classes: 1st. The *intrinsic*, yielded by the Flint *haches* and by the jaw, regarded *per se* through their physical characters. 2nd. The *extrinsic*, or that connected with the beds in which the objects were asserted to have been found.

In many important respects the first was directly at variance with the second, which appears to have weighed most with the Conference in determining the conclusions at which it arrived. On the present occasion it is proposed to give a summary and analysis of the evidence as set forth in the *procès-verbaux*, together with the results of some later inquiries, where it was incomplete.

The Flint *haches* and the human jaw, although in their nature so widely different, were intimately connected in this case, from the fact that they were both said to have been

yielded by the same deposit; and the most important pieces among the former were covered with the same matrix as the latter. If either proved to be open to suspicion upon the internal evidence, doubt was *pro tanto* reflected upon the other. I shall therefore consider the evidence of the *haches* as well as of the jaw.

1. *Intrinsic Evidence of the Haches.*—And first as regards the *haches*. Suppose a mass of a compact hard, homogeneous, non-crystalline, mineral substance like Obsidian or Flint, presenting a flat surface. Let a blow be struck perpendicularly to the latter, with moderate force, by a light convex iron hammer, anywhere near the centre, and an invariable result follows. Although not visible externally, a partial solution of continuity takes place in the interior of the mass, in the form of a cone of which the point of impact constitutes the apex. Suppose the mass to have the shape of a polygonal block, and a similar blow to be struck near the periphery, where there is a line of least resistance, a *flake* will be detached; and as from the given conditions there is not sufficient thickness of substance for the vibrations being propagated uniformly all round, instead of a cone, the flake presents a conoid surface, the immediate apex of which above, corresponding with the point of impact, is a true cone. The general convex surface which results may be compared to that of one of the valves of a convex bi-valve shell; and the hollow which it leaves on the block is commonly known under the name of 'conchoidal fracture.' The phenomena have long been observed, but although manifestly dependent on a definite physical cause, they have not yet, so far as I have been able to ascertain, been made the subject of mathematical analysis.

Suppose the same conditions in another block, but let the blows be struck with a piece of flint or other hard stone; the same effects are produced, but modified. In the one case the resultant cone is more depressed, and in the other the conoid convexity, 'or bulb of impact' on the flake, is less prominent and extended over a broader surface. A necessary consequence is that the conchoidal facets produced by the repeated detachment of flakes, or splinters, when *stone-struck*, are broader and shallower, and the dividing ridges less elevated; while *iron-struck* facets are deeper, narrower, and more pronounced, with more elevated and more angular dividing ridges. I put the case in the most general terms, as founded on observation. The principal cause of the difference has still to be made out; but one thing is certain, that commonly the facets, upon the most ancient *haches*, are shallower and less pronounced than in modern imitations.

The Flint-objects, which are accepted as proofs of human industry of very remote antiquity, are therefore of two kinds. 1st. The more simple, or flakes. 2nd. The *haches*, which have been shaped out of blocks into form by the repeated detachment of small fragments or *éclats*.

Where *haches* occur, flakes designed for use commonly occur also.

Flint *haches*, of undoubted antiquity, bear certain marks, the presence of one or more of which is considered necessary to guarantee their genuineness. 1st. They are weather-stained or discoloured, according to the nature of the embedding deposit. 2nd. They present a general polish or vitreous glimmer, which is not seen on the dull fresh fracture of the same flint. 3rd. They are patched over with a *patina*, consisting of a crust of carbonate of lime, or of other mineral matter, or they bear dendrites.

Besides these, there are other indications which, regarded *per se*, are less certain and constant, but which assist materially in judging on the genuineness of *haches*. 1st. Commonly they are more or less used and blunted or indented at their sharp edges, and they are frequently abraded by rolling. 2nd. The conchoidal facets, caused by the detachment of flakes, are broad and shallow, and the dividing ridges but little conspicuous. 3rd. Residuary films are either absent from the facets, or, if present, their margins are broken, and colouring matter in matrix is generally interposed between them and the body of the flint, through capillary action.

The broad and shallow facet and the low dividing ridges have been closely imitated by using stone hammers at the present time; but in certain cases *haches*, considered upon other grounds to be of genuine antiquity, present conchoidal facets and raised dividing ridges. In others, the points or edges are uninjured. In these instances the vitreous glimmer, dendrite, or other kind of *patina*, are relied upon as tests of their genuine character. Occasionally the discrimination, except by practised experts, is difficult and perplexing.

Counterfeit *haches* of modern fabrication are commonly distinguishable with readiness, by the absence of all the characters above indicated, and by the presence of certain peculiar marks. 1st. They present no vitreous glimmer different from a fresh fracture; they are unstained, unweathered, and free from dendrites or other *patina*; and they bear no marks of rolling. 2nd. The facets are more conchoidal, narrower, deeper, and commonly more numerous; and the dividing ridges well pronounced, angular, and

unworn. 3rd. The edges all round are sharp, fresh, and unworn; or, if indented, the breaks are unequal, with crushed fractures. 4th. The facets present more or less numerous, broad and entire, residuary films, free from underlying matrix. 5th. They are frequently finished by vertical blows on the broad surface, to reduce some inconvenient salient inequality, leaving rude crushed fractures, which occasionally present streaks of metallic iron. 6th. They are commonly ruder in form, and an experienced eye will detect the difference; but this indication is not to be relied on.

The Flint-implements from Moulin-Quignon were of two kinds. 1st. A few *haches*, and a corresponding number of flakes, which were universally accepted as being unquestionably genuine. The *haches* were rolled, highly weathered, and uniformly deeply stained with iron; polish vitreous; facets broad and shallow, without films; ridges low and inconspicuous; edges much worn and rounded. In short, they presented more decided marks of age and rolling than most of those found in the other localities of the Valley of the Somme. The flakes were also tinged with iron, and equally genuine and ancient in appearance. The majority of both appear to have been got before the present year, and to have been yielded by the ferruginous gravel. Not a single specimen of either, derived from the 'black seam,' was laid before the Conference. 2nd. A large number of *haches*, without the admixture, so far as I remember, of a single flake, and all, when denuded of their matrix and well washed, presenting the most marked contrast to the genuine specimens from the same locality. The English members of the Conference produced about twenty, most of them procured within the last three months, from the 'black seam' or overlying ferruginous gravel; and a considerable or nearly equal number was presented by the French members. When washed they yielded the following characters:—Outline generally of the spear-headed pattern; a few oval or almond-shaped, and the majority of them coarsely wrought, with a great sameness of pattern, as if the production of one or two hands; surface with the dull appearance of a recent fracture, and without glimmer, dendrites, incrustation, or *patina* of any sort; colour, even where greyish-white and porous, unaltered, and substance perfectly free from ferruginous infiltration; facets conchoidal, with angular dividing ridges; films numerous, broad, and entire, without underlying matrix; edges sharp, continuous, not rolled, and either unindented, or where interrupted showing recent angular fractures. Where a new fracture was made before the Conference, the fresh surface differed in no respect from that of the rest of the flint. Such at

least was the view held by the English members, as set forth in the *procès-verbaux*.

Further, two of these *haches*, procured by me at Moulin-Quignon, on the 14th and 15th April, presented on the middle of the thickest part an appearance which Mr. Evans and myself interpreted as being probably the result of a vertical blow applied with an iron hammer, to reduce an inconvenient inequality. One got by Mr. Nicholas Brady, on the 17th April, upon being carefully washed by me yielded immediately afterwards a distinct streak of metallic iron. It was observed at the time by Dr. Charles Murchison, Messrs. Antonio and Nicholas Brady, and myself. It was examined on the following day, under the microscope by Dr. Carpenter, who confirmed the observation. It was suggested at the Conference that the iron marks in this instance may have been caused by the pick-axe of the pitman; but the explanation was insufficient, inasmuch as the covering of matrix was carefully examined before washing, and it presented no external marks corresponding with the streak. These *haches* were compared with modern counterfeit *haches* of known English origin, and so far as surface, facets, sharp edges, and fresh look are concerned, they exhibited no appreciable difference of material value.

All these flint-implements, of the suspected character, whether covered with ferruginous gritty sand or with 'black-seam' matrix, were coated superficially by a subjacent thin dark film, which by slight washing was reduced to a bronze-tint, and entirely removed by scrubbing with a brush and hot water. The scrutiny of the Conference was mainly directed to those which came out of the 'black seam' that yielded the jaw. The coating of matrix upon them was regarded by M. de Quatrefages, resting upon the opinion of M. Delesse, subsequently confirmed by Professor Delafosse, as being natural, from the fact that there was an appearance of minutely mammilliform aggregations of 'Limonite of iron' upon the surface of the *haches*. But they had no firm adhesion to the flints, and although presenting occasional points of metallic brilliancy, they were removed with the utmost facility by washing. The English members, throughout the sittings devoted to this part of the case, saw no reason to regard the matrix as other than a coating artificially laid on. Mr. Evans found by experiment, that the fine dry powder of the 'black seam' gravel, consisting of earthy matter charged with oxides of iron and manganese, when moistened and rubbed on with the finger, exactly reproduced the same appearance, and also the bronze tint remaining upon the suspected *haches* when half-washed. Where the black matter

was insinuated into the pores of the whitish-grey incompact parts of the flints, there was some difficulty in removing the specks with the brush.

The characters of the flint-gravel of the 'black seam,' an important part of the evidence, were submitted to examination. Specimens were handed in on both sides. The great majority of the pebbles, and more especially the larger ones, were deeply stained with iron or covered with *dendrites*. The French members produced some fragments, mostly small and angular, which when washed they considered to be nearly free from tinting. The precise numerical *ratio* of the latter to the former was not determined at the Conference. The English members held, that the exceptions were so few as not materially to alter the complexion of the evidence. Dr. Carpenter, by a written question which he handed in to be put to Professor Delafosse, implied that while the suspected *haches* were 'free from coloration or dendrites, the ordinary flints of the same bed *universally* presented such indications.' Mr. Evans states that 'the pebbles in the "black band," in which the *haches* are said to have been principally found, are without exception more or less stained by the ferruginous matrix, a stain which cannot be removed by washing.' Mr. Prestwich, during his subsequent visit to Abbeville, took the opportunity of making the experiment omitted by the Conference. He washed a portion of the gravel containing 135 flint-fragments, and found that 108 of them were completely stained and coloured, 22 partially so, and only 5 (*all small*) not at all altered: the last thus forming less than 4 per cent. of the whole. He admits 'that the rarity, therefore, of unaltered flints in this bed is in contradiction to the unaltered condition to the totality of the flint implements of the new type,' *i.e.* the suspected ones.

The thin layer of argillaceo-metalliferous matter, constituting the 'couche noire' or 'black seam' proper, was also examined. It lay immediately upon the chalk, portions of which adhered to the under surface of ten specimens exhibited. No detailed chemical analysis of this substance was submitted to the Conference; but a qualitative analysis was communicated, showing that it consisted of fine earthy matter highly charged with oxides of iron and manganese, and that it contained no organic materials. Professor Williamson, of University College, has since caused a careful analysis of the substance to be made, in the 'Birkbeck Laboratory,' by his able assistant Mr. Haughton Gill. The results, published in one of the explanatory notes appended to the *procès-verbaux*, establish that more than half of the substance of the 'couche noire' consists of matter insoluble in hydrochloric acid, and

the residue, chiefly of alumina and oxide of iron, and of oxide of manganese, in variable quantities in different portions of the matrix; and that it contained no *humus* or other organic constituent. The matters analyzed consisted of the 'black seam' proper; of the same derived from the black flinty gravel; and of portions of the black covering of the jaw and of matter extracted from the hollow tooth. They were all shown to be made up of the same constituents, although in different proportions, and they are regarded as being of the same nature.

M. de Quatrefages exhibited to the Conference a flake-like fragment, of a white, hard, and solid substance, extracted by him from the matrix of the 'couche noire,' and remaining uncoloured. He contended that as this body was unstained, the absence of staining in the suspected *haches* might in a similar manner be accounted for. The precise nature of the body in question was not ascertained; it was first regarded as being probably a portion of a tooth, and then, when examined by the Conference, as possibly portion of a shell (?). Hairs, coloured and uncoloured, were also disengaged from specimens of the 'couche noire.' They were regarded as being of Rodents or of Bats, but there is good reason to suspect, according to Mr. Busk, that their presence was purely accidental.

The general results yielded by the examination of the *haches* and accompanying circumstances, apart from the *gisement*, were differently regarded by the different sides. M. Milne-Edwards, President of the Conference, in his communication made to the Academy of Sciences on May 18th, puts the case thus:—

'Tous les membres de la réunion ont été d'accord pour admettre que dans beaucoup de cas, à raison de l'existence de certains caractères qui semblent ne pouvoir être imprimés que par le temps, on peut, par la seule inspection d'une hache en silex, constater son authenticité, c'est-à-dire son origine ancienne. Mais les avis ont été partagés au sujet des bases d'un jugement légitime en sens contraire.

'MM. Falconer, Prestwich, Carpenter et Busk pensaient que l'absence de tout signe évident de vétusté et l'existence de certaines particularités dans la forme ou dans les fractures de ces haches étaient des preuves irrécusables de leur fabrication récente. Ces savants se considéraient, par conséquent, comme fondés à nier l'authenticité des haches dont la surface ne présentait ni patine ni incrustations, dont les arêtes étaient très-vives et dont la forme s'éloignait plus ou moins de celle des haches reconnues vraies. Puis, faisant l'application de ces principes aux haches tirées des diverses couches du terrain de transport de Moulin-Quignon ou d'autres lieux, ils admettaient l'authenticité des unes, tandis qu'ils déclaraient fausses beaucoup d'autres, notamment toutes celles provenant de la couche noire où M. de Perthes avait trouvé la mâchoire humaine.

'MM. de Quatrefages, Desnoyers et Lartet, ainsi que les autres naturalistes français qui prirent part à cette partie de l'enquête, soutinrent qu'il fallait être plus réservé ; que très-rarement, peut-être même jamais, des particularités de forme, une apparence de fraîcheur ou d'autres caractères intrinsèques du même ordre, ne pouvaient suffire pour bien établir la fausseté d'une de ces haches en silex ; que des caractères de ce genre pouvaient inspirer des doutes, et qu'à défaut d'autres données ces doutes devaient peser beaucoup dans nos jugements ; mais que les considérations tirées du mode de gisement de ces instruments et des circonstances dans lesquelles leur découverte a eu lieu devaient avoir à nos yeux une valeur bien plus grande ; enfin, que des preuves d'authenticité obtenues de la sorte doivent toujours l'emporter sur les soupçons que pourraient faire naître les particularités dont je viens de parler. Ainsi ces naturalistes furent unanimes dans le jugement qu'ils portèrent sur l'une des haches trouvées dans la couche noire de Moulin-Quignon par M. de Quatrefages : malgré la facilité avec laquelle la surface lisse de ce silex se laissait dépouiller de sa gangue, malgré sa forme, la vivacité de ses arêtes, et malgré son aspect de fraîcheur, ils n'hésitèrent pas à en admettre l'authenticité, par cela seul que les circonstances dans lesquelles ce savant l'avait découvert dans le sein de la terre leur paraissaient exclure toute idée de supercherie. Par conséquent, MM. Desnoyers, Lartet et Delesse, aussi bien que tous les autres naturalistes français qui assistaient à cette discussion, ont déclaré que dans leur opinion le jugement porté sur les haches de la couche noire de Moulin-Quignon, par M. Falconer, ne pouvait légitimer aucune conclusion touchant l'introduction frauduleuse de la mâchoire humaine dans le dépôt de gravier où M. Boucher de Perthes avait trouvé cet os.'

The grounds of the doubts maintained by the English members, during the three sittings of the Conference devoted to the subject of the *haches* may be enumerated thus :

The *haches* formed two sets, exhibiting the most contrasted differences, the one consisting of *haches* and flakes highly weathered, discoloured or iron-tinted, and occasionally much rolled, both bearing every mark of antiquity, and unanimously accepted as genuine. The other set absolutely fresh-looking, having sharp edges, unweathered, unstained, free from marks of rolling, and unaccompanied by a single flake ; there was a wide chasm between the two sorts, and no intermediate links to connect them. The recent-looking series were yielded by all parts of the section below the *Loess*, alike by the ochreous gravel and by the 'black seam.' The flint fragments in both deposits were, as a general rule, more or less stained with iron, while not a single specimen among the suspected *haches* was appreciably tinted. The gravel and sands of the section are freely permeable to water down to the chalk, and the mangano-ferruginous layer of the 'black seam' also readily imbibed moisture. According to Mr. Prestwich, the most certain of all the tests of the authenticity of a *hache* is its identity in mineral character with that

of the component flints of the beds in which it occurs. How then, it may be asked, could these *haches*, jointly exposing several square feet of surface, have remained for a length of time under such conditions and escaped staining or dendritic incrustations? If it were assumed from their sharp edges and freedom from rolling that they had been manufactured in the neighbourhood, how was the entire absence of corresponding flakes to be accounted for? Genuine *haches*, according to Mr. Evans, have been comparatively rare at Moulin-Quignon, where they have been found for upwards of twenty years. Not one of this description, universally so admitted, from the 'black seam,' was laid before the Conference, while *haches* of the suspected character have turned up in extraordinary abundance, all of a sudden, within a late period. It was stated at the Conference that more had been yielded at Moulin-Quignon within the last few months than of the genuine kind during several previous years. Nor were they confined to Moulin-Quignon. Specimens were submitted, professing to have been yielded by the gravel-pits of Mautort and Saint Gilles, and exhibiting the rudest attempt at fabrication, but disguised by a coating of black matrix smeared over them. One of these, from Mautort, according to a manuscript note of Dr. Carpenter, was 'given up as factitious;' and on another from St. Gilles, Mr. Busk pointed out that the matrix contained 'unquestionable fragments of recent vegetable structure.' One ingredient of fraud in the case of the *haches*, clearly made out, was sufficient to cast doubts on the rest of the series, which of themselves were intrinsically suspected upon other grounds. The French members, according to M. Milne-Edwards, held by one of the *haches*, found by M. de Quatrefages in the 'couche noire.' But its genuine character was not accepted on this intrinsic evidence by the English members, during the three sittings of the Conference at Paris. And, even if admitted to be genuine, it would have gone for little as evidence in the main case; for, on the hypothesis that the great majority of the questionable specimens had been artificially placed beforehand by the pitmen in the situations where they were found, it might have been expected that some genuine specimens would have been introduced to give countenance to the others. Further, it is well known that in all countries where coins, antiquities, or archæological objects are in demand, counterfeits are offered abundantly in the market. That Abbeville should have formed an exception to the general law was, in the abstract, more than could have been expected. But it was notorious that an active fabrication of counterfeit flint-implements was carried on both at Amiens and Abbeville,

to meet the lively demand caused by the authentic discoveries made by M. Boucher de Perthes and others in the Valley of the Somme. Mr. Evans, whose verdict on this point is of the highest authority, states that a year ago he purchased 'an indisputably forged drift-implement from one of the *terrassiers* of Abbeville.' Numerous other instances of the same kind might be cited if necessary. Some of the implements from Moulin-Quignon and Mautort, professing to be ancient, were upon the internal evidence as certainly modern counterfeits as an inference of this nature could be established, in default of the testimony of eye-witnesses to the act of manufacturing them. That the traffic in counterfeit *haches* is remunerative to some of those concerned in it is sufficiently proved by the fact, that five francs are commonly demanded of strangers at Amiens and Abbeville for the coveted privilege of detaching from its bed a *hache* professing to be found *in situ*. It is within my knowledge, from the direct statements of the parties, that this has occurred to two Englishmen during the month of last April: to the one at Amiens, to the other at Abbeville. Each was asked, and each paid, five francs. In the latter case, the specimen was submitted to the Conference as one of the series of counterfeits from Moulin-Quignon; it having been regarded in that light when brought to England and examined by Mr. Evans, Mr. Prestwich, and myself. The great demand for flint-implements arises from the number of strangers who now visit Amiens and Abbeville, attracted by the general interest which the subject has of late years excited. The supply of genuine implements proved insufficient, and the natural result followed. Considering the facility with which counterfeits can be made, half a franc per *hache* would upon a considerable sale be amply remunerative, apart from the larger sum derived from specimens professing to occur *in situ*.

2. *Intrinsic Evidence of the Jaw.*—So much time was spent on the question of the flints, which occupied the greater part of the three meetings of the Conference at Paris, that little space remained for the examination of the principal object, the jaw itself; and this part of the case was gone through in a much more summary manner. The 'detached molar,' covered with matrix of the 'black seam,' which had been sawn up in London, and upon which so much weight was at the time vested, was, by the consent of both sides, withdrawn from the case, as being open to question on the score of identification. But it gave rise to a discussion as to the value of the quantitative presence of gelatine as a test of fossil teeth. Two specimens, from the *Diluvium* of Anvers, were produced by M. Delesse, the one the canine and the other

the lower fang of a molar of *Hyæna spelæa*, as proofs of the retention of gelatine in undoubted Quaternary fossils. But the former adhered very strongly to the tongue, having lost a very considerable portion of its gelatine, and the latter, although non-adherent, had altered much in colour and become yellow. Further, they hardly bore on the particular case, inasmuch as the conditions of the beds may have been very different, preservative in their nature in the one, and not so in the other. For it was not shown that the Anvers specimens had been embedded in a deposit charged with mangano-ferruginous oxides.

The matrix covering the jaw was first examined. It was regarded on the one side as being a natural deposit; on the other as a coating which had been laid on, or otherwise produced artificially. Besides MM. Delesse and Hébert, M. Delafosse, Professor of Mineralogy, who examined it in the presence of the Conference, expressed his opinion that the coating was natural, indicating that the bone had long been embedded in the matrix. He expressed the same opinion regarding the matrix of some of the flint *haches*. He 'was shown a *hache* from Mautort, which had been previously given up as factitious, and pronounced the *gangue* to be a natural and ancient deposit.' The doubts of the English members, that the coating was artificial, were not shaken by this verdict upon the Mautort and other *haches* detailed in the *procès-verbaux*, one of them having exhibited in its matrix 'unquestionable fragments of recent vegetable structure.' Chemical analysis, undertaken since the close of the Conference, has shown that the matrix of the 'black seam' and the coating upon the suspected *haches* and upon the jaw are alike in their composition, although differing quantitatively in the constituents. The English members rested their doubts: 1st. Upon the absence of staining by the matrix both upon the *haches* and upon the jaw. 2nd. On the facility with which the coating upon both was removed by washing. The French members appear to have relied on the presence of occasional brilliant points, upon the granular clusters of '*limonite de fer*,' as indicating a natural origin.

The jaw was carefully sawn across by Mr. Busk, immediately in front of the solitary penultimate molar, and the section was so conducted as to include vertically a portion of one of the fangs. The specimen consisted of the left ramus, perfectly entire, of a human subject, estimated to have been between 60 and 70 years of age. Although yielded by a bed of flint gravel there was not the slightest appearance of crushing or mark of rolled action, the condyle and thin apex of the coronoid being as perfect as in a recent bone. The

black coating of the supposed natural matrix was washed off the surface of one of the segments with great facility. But small specks of the same fine black matter remained in some of the minute hollows and miliary pores. These were removed without difficulty by the application of a tooth-brush. The general colour of the washed surface was a light buff, mottled with faint brownish stains, which were persistent, resembling those frequently observable in bones that have lain long buried in the earth. But the outer surface was tolerably smooth and perfect, presenting little indication of the superficial erosion commonly seen on old bones derived from cemeteries. There was no appearance either on the exterior or within of dendritic deposits. This is a point in which the jaw differed remarkably from other bones of undoubted fossil antiquity, found in the Somme gravel deposits, and which contrasted also strongly with the jaw in the greater amount of alteration by loss of gelatine which they had undergone. The substance of the bone was dry and friable towards the alveolar border, but on the whole it was tolerably firm under the sand and but little altered, and the fresh section afforded a distinct odour of sawn bone. Internally the structure was *absolutely free from any sign of mineral impregnation.* The cortical layer, which was remarkably thin and condensed, was nearly white, and the walls of the empty cancelli of a faint brownish tint. The upper aperture of the dental canal was covered over with the black coating, which had penetrated well into the mental foramen. The most remarkable appearance in the section was the lining, as it were, of the middle portion of the same canal, with a thin layer of fine grey sand, easily removed by the point of a needle, and which, when examined under the microscope, was seen to consist of minute grains of white quartz or silex, intermixed with a few particles of oxide of iron, but without a speck of the black matrix. The section of the fang showed that the dentine, so far as exposed, was perfectly white, full of gelatine, and in no respect different in appearance from that of a recent tooth. In short, it reproduced exactly the characters which I had previously described as yielded by the section of the fang of the 'detached molar,' and which had impressed me and others so strongly with the conviction of its being a recent tooth. The body of the molar present in the jaw was hollow from *caries*, but the enamel was white and brilliant, and without the slightest appearance of alteration. The *crusta petrosa*, very little of which was present, was very faintly coloured. The socket towards the upper part was not completely filled by the fang, and the interval was partially occupied by the black matrix

of the coating, and by sandy particles. One important part of the intrinsic evidence still remained to be determined, namely, the chemical analysis of the bone; but the Conference was too pressed for time to wait for it, and the recent characters were in other respects so pronounced, that no one thought of urging the point. The opinion expressed by Professor Busk, after his examination of the bone was completed, was 'that the bone is of considerable but not of very high antiquity, and that it presents no character which may not be found in cemetery bones.'[1] Professor Busk's long study of, and well known familiarity with, the subject invest his opinion on this point with the stamp of authority. The jaw was compared on the one hand with a specimen in the possession of Professor Busk, derived from a Gallo-Roman cemetery, near Amiens, from which it differed chiefly in being a little more altered, and in the latter showing no layer of sand lining the dental canal, when sawn across. On the other hand, it was compared with a very remarkable lower jaw, found in a coprolite pit near Ipswich, and now belonging to Dr. Robert Collyer, which, although retaining a portion of its gelatine, is infiltrated through and through with iron. The section of the cortical layer is dark; oxide of iron is seen filling the Haversian canals; a dark crust of the same metal cover the walls of the cancelli; coarse grains of sand, with red oxide of iron, line the walls of the dental canal; and a vertical section of one of the fangs of a molar shows that the dentine is partly infiltrated with iron. The precise age of the Ipswich jaw is not known, but it is conjectured not to exceed that of the Roman occupation of England. Mr. Busk has ascertained, since the Conference, that part of a human pelvis and other bones, belonging to two bodies, in the collection of M. Boucher de Perthes, and inferred by Mr. Prestwich and Mr. Evans to have been interred in an open trench in the gravel below the *Loess*, near Mesnières, probably during the early part of the Celtic period, were all more or less marked with dendrites. The Moulin-Quignon jaw, although reported to have been yielded by a deposit of mangano-ferruginous earth, presented the remarkable and exceptional phenomenon of being absolutely free from metallic infiltration or dendritic patches. Those who are conversant with fossil bones will not readily believe that the age of the individual, probably above sixty years, and the density of the bone this implied, constituted an adequate cause of resistance to the process. That bones are very susceptible of staining and infiltration by metallic matter, even during the act of maceration, is well known. Nor

[1] Copied verbatim from Dr. Carpenter's notes of the proceedings, taken at the time.

is the action limited to iron and manganese. Professor Huxley has described remains of *Macrauchenia Boliviensis*, from the copper mine of Santa Rosa, in Bolivia, 'in which the bones are all in the same, and that a very peculiar, mineral condition, the Haversian canals being for the most part filled up with threads of native copper, so that the fossils are not only exceedingly dense, but in consequence of their internal flexible metallic support, their thinner and more delicate parts bend, rather than break, when force is applied to them.'[1] Mr. David Forbes, in his account of the geological structure of the region, states 'that the bones themselves are in some instances almost converted into copper, or at least the pores are filled with that metal—a circumstance easily accounted for in strata so highly impregnated with it.'[2]

The labours of the Conference in Paris terminated at this point, and the published *procès-verbaux* show that the three English members who took a share in the discussion maintained, upon the intrinsic evidence throughout, that the black coating on the human jaw was not a natural deposit, and that the recent condition of the bone was not consistent with its having been yielded by the 'black seam' as an original occupant of the bed. The layer of gray sand in the dental canal, and the absence of penetration by the black matrix, suggested the inference that the former was the result of a previous sepulture, and that the latter had been laid on.

M. Milne-Edwards, in his communication to the Academy of Sciences, already cited, puts the divergence of opinion between the English and French members thus:—

'De l'ensemble de ces faits, MM. Falconer, Prestwich, Carpenter et Busk conclurent qu'il y avait eu fraude au sujet de cet os aussi bien que pour les haches de la couche inférieure du terrain de Moulin-Quignon; que tous ces objets devaient être considérés comme très-récents et que, suivant toute probabilité, les ouvriers de la carrière, après les avoir enduits artificiellement avec de la matière terreuse provenant de cette couche noire, les avaient enfouis dans une excavation de la carrière, où leur présence aurait été ensuite signalée à M. Boucher de Perthes comme une découverte inattendue.

'M. de Quatrefages et les autres membres français de la réunion ne crurent pas devoir tirer les mêmes conclusions des faits observés. Ils constatèrent que des cailloux ordinaires tirés de la couche noire de Moulin-Quignon, pour servir à l'entretien des routes, se laissaient quelquefois nettoyer par le lavage non moins facilement que la mâchoire, et que tous les arguments déjà présentés au sujet de l'influence des différentes conditions de gisement sur le degré d'altération des fossiles étaient applicables à cet os aussi bien qu'à la molaire isolée.'

[1] Quarterly Journ. Geolog. Society, 1861, vol. xvii. p. 74.
[2] *Idem*, p. 47.

To summarize the result of the intrinsic evidence in the view here taken.

1. The suspected *haches* showed the characters which are found in modern fabrications, and they were wanting in all those which stamp *haches* of unquestionable antiquity.

2. The human jaw exhibited the physical characters which belong to ancient bones of the modern period, and it was wanting in those commonly seen in Quaternary fossil bones of undoubted antiquity occurring under analogous conditions.

One part of the case which was entered for inquiry upon the *programme* forwarded from London before the meeting of the Conference, was not gone into at all, viz. the anatomical character of the jaw, as significant of race-distinction. The issue was narrowed to *fossil*, or *non-fossil*; and on the present occasion I shall not cumber this communication by any remarks on the subject, although fully impressed with its importance.

[The precise measurements of the jaw were as follows:[1]

Dimensions of Fossil Lower Jaw (Moulin-Quignon)	Inches
1. Extreme length of ramus from chin to poster. edge of condyle by callipers	5·0
2. Length of horizontal ramus from anterior marg. coronoid to incisive border	2·6
3. Height of ascending ramus to apex of coronoid	2·2
4. Height of sigmoid notch measured parallel to posterior border along middle of ascending ramus	1·9
5. Width of ascending ramus at constriction	1·1
6. Antero-post. extent of sigmoid notch (from edge of condyle to ditto coronoid)	1·3
7. Height of sigmoid notch	0·53
8. Height of jaw at incisive border	1·13
9. Ditto at middle *exact* where antepenult. alveol. filled up	1·2
10. Ditto behind last molar alveolus	1·2
11. Transverse diameter of condyle	0·78
12. Antero-posterior of condyle	0·4]

B. *Extrinsic Evidence.*—The counterfeit characters of the Moulin-Quignon *haches* of the 'black seam,' insisted upon by the English members of the Conference, were contested *seriatim*, and more especially the films, by the French members. M. Desnoyers, at the second sitting, in view of this difference of opinion, and of the admitted difficulty in certain cases of distinguishing the *genuine* from the *counterfeit*, urged that the material proof was, above all, a question of *gisement*; and that if the position of a *hache* in the deposit were proved to be unquestionable, the *hache* ought to be accepted as genuine, whatever might be the characters which it presented. Others of the French *savants* advocated the same view. One of the English members replied that he fully admitted the importance of the evidence yielded by the *gisement*; but that

[1] Extracted from Author's Note-book. - [Ed.]

it was liable to so many sources of fallacy and errors of judgment on the observation, that it must be received with great caution; and that if the French members of the Conference refused to entertain as evidence the *intrinsic* characters on which he relied so much, and rested entirely upon the circumstantial, he should not feel warranted in advancing further into the inquiry, and must withdraw from the Conference. In the end, however, the *gisement* determined the conclusions arrived at.

The Conference, augmented by a considerable number of French *savants*, proceeded to Abbeville on May 12, and commenced operations on the gravel-pit of Moulin-Quignon. The face of the section had been worked back about 10 or 12 feet from the spot where the jaw was asserted to have been found, and the debris was piled up in mass upon the spot. The 'black seam' proper, consisting of a thin layer of mangano-ferruginous oxides, proved to have been a very local deposit or *pocket*, which had been worked out. The face of the gravel section showed abundant signs, either of disturbance or of derangement, natural or artificial, and if the latter, not of a very recent date. Three chasms, interpreted to be '*puisards*' or 'sand-pipes,' separated by no great interval, were seen descending from the surface to the chalk; near the middle of the section masses of sand presented the appearance of having been let down into the gravel, and the ferruginous gravel at the south end of the section exhibited no distinguishable marks of stratification. The section of one of the so-called 'puisards' pointed in a direction which, if continued outwards, would not have been more distant than a few feet from the spot where the jaw was asserted to have been found. M. Hébert, the eminent professor of geology to the Sorbonne, after examining the gravel-pit, insisted very strongly to the French geologists around him that the Moulin-Quignon deposit, if not *remanié*, did not belong at all to the series of *Diluvium*, or 'Ancient Quaternary' sands and gravels of the Valley of the Somme, such as those of Menchecourt and St. Acheul; but that it was a formation of a much later date. Thin seams of 'gray sand' were observed a few feet above the chalk, in that part of the section which corresponded with the direction of the spot where the jaw was found. It was held by some of the members of the Conference that the sand might account for the 'lining' of the dental canal; that the jaw might have been first in this alluvial sand before it got into the 'black-seam.' There was no means at the time of comparing the two sands under the microscope, and taking all the circumstances of the case into account, the conjecture did not appear to me to furnish a

satisfactory explanation. A large party of workmen were employed, under the inspection of the Conference and of other French *savants*, in search of flint *haches*, five of which were yielded during the operations of the day; and in no case was any circumstance observed or noted which would justify the opinion that they had been fraudulently introduced. I was a witness to the appearance of two. One of them was disclosed by a fall of a part of the section undermined by the pick-axe, and on being summoned to the spot, I saw it, not engaged in the gravel, but supported on the hand of M. Alphonse-Edwards, before it fell, at the spot where it was observed. On moving his hand it dropped without leaving any impression. The other was brought up to M. Bert from near the edge of one of the so-called 'puisards,' when I was standing above, close by him; but no mark of its impression could be seen in the incoherent gravel. Four of these *haches* were afterwards handed over to Mr. Prestwich for detailed examination, one of them having been retained in the condition in which it was found, by the president, M. Milne-Edwards. The four which were brought to England have been washed and carefully examined by Mr. Prestwich and myself. They maintain the same character of contradictory and incompatible evidence, which has been evinced throughout in this extraordinary case. One of them bears the most pronounced marks of antiquity, in form, rolling, facets, weathering, glimmer, and uniform staining; while the other three exhibit every positive and negative character, which we have held to throughout, as stamping *haches* of modern fabrication! There was no intermediate condition. I append a descriptive note of each.[1]

These *haches* were examined, in a cursory manner, by the

[1] Notes on the specimens of flint-implements found at Moulin-Quignon, in presence of the Commission, May 12, 1863, dictated by H. F. to Mr. Prestwich:—

No. 1. Labelled '*Found in situ*' (A. Edwards).—Form and contour narrow, ovato-lanceolate, sharp all round the edge and at the base; thick; facets very irregular and deep, like those regarded by me and Mr. Evans as unauthentic; ridges separating the facets high and angular; surface where washed, like that of a recent flint; no dendrites, no patina, no incrustation, and no glimmer of rolling; thin films, of considerable extent, without any fracture of margin—of the unauthentic character.

No. 2. Washed on one side; covered with ochreous sandy matrix on the other; in form ovate; point broken off, but fracture rounded; body thin; facets shallow, like the true St. Acheul type; discoloured surface with a bright glimmer; margin all round more or less obtuse—of the authentic type.

No. 3. Ovate in outline like the last, but point entire. In all other respects, as regards facets, fracture, &c., like No. 1.—of the unauthentic type.

No. 4. Pointed ovate, but in surface, fracture, &c., fresh-looking, like No. 3; facets excessively rude; ridges high, and upon the thick part, on one side, a rude irregular pit, as if caused by a vertical blow. Some of the films very large, excessively thin, quite entire, and not the least mark of matrix below—of the suspected or unauthentic type.

Conference, late at night; yet it will be seen, that the fact of finding them to all appearance *in situ* in an undisturbed position determined the verdict given in conclusion No. 3, that 'the greater part, if not the whole, of the *haches* from the lower part of the gravel-pit of Moulin-Quignon are authentic.'

The evidence of the eye-witnesses to the finding of the jaw was then taken, and it was so consistent and direct that no flaw was detected, and it satisfied the Conference.

The operations on the gravel-pit of Moulin-Quignon were hurried through in a single day, and although the results were relied on, it is but right to indicate that with such a number of workmen, dispersed over different parts of the section, and with so many observers, the conditions were not the most favourable for the close and severe scrutiny required in a case of critical observation.

The Conference had now reached the fifth day of its labours, and it was necessary to come to some conclusion. The English members were compelled, by business engagements, to return to London. Assuming the Moulin-Quignon deposit to be of the age assigned to it by Mr. Prestwich, *i.e.* a 'high-level' gravel of the oldest Quaternary period in the Valley of the Somme, the *intrinsic* evidence yielded both by the flint *haches* and by the jaw was wholly irreconcileable with the direct results arrived at under the eyes of the Conference, and with the testimony of witnesses as to the finding of the jaw; but if it was a disturbed or comparatively late deposit, although still embarrassed by formidable difficulties, there might be a way to a possible explanation. To have persisted in attributing fraud in the case, without direct evidence, whatever suspicions might be entertained, would have been unwarrantable. The following conclusions were arrived at: the French members and Mr. Prestwich being unanimous in their assent to all:—

'1. La mâchoire en question n'a pas été introduite frauduleusement dans la carrière du Moulin-Quignon; elle existait préalablement dans l'endroit où M. Boucher de Perthes l'a trouvée le 28ième mars dernier. Cette conclusion a été adoptée à l'unanimité.

'2. Tout tend à faire penser que le dépôt de cette mâchoire a été contemporain de celui des cailloux et autres matériaux qui constituent l'amas argilo-graveleux, désigné sous le nom de "Couche Noire," laquelle repose immédiatement sur la craie. Cette conclusion a été adoptée par tous les membres présents, à l'exception de MM. Falconer et Busk, qui réservent leur opinion jusqu'à plus ample informé.

'3. Les silex taillés, en forme de haches, qui ont été présentés à la réunion comme ayant été trouvés vers la même époque dans les parties inférieures de la carrière du Moulin-Quignon, sont pour la plupart, si non tous, bien authentiques.

'Cette 3ième conclusion a été adoptée par toutes les personnes présentes sauf par M. Falconer, qui réserve son opinion jusqu'à plus ample informé.

'4. Il n'y a aucune raison suffisante pour révoquer en doute la contemporanéité du dépôt des silex taillés avec celui de la mâchoire trouvée dans la "Couche Noire."

'Cette proposition est adoptée par tous les membres de la réunion sauf par MM. Falconer et Busk, qui désirent réserver leur opinion.'

My verdict on the whole case, which is embodied in the *procès-verbaux*, was as follows :—

'I am of opinion that the finding of the human jaw at Moulin-Quignon is authentic; but that the characters which it presents, taken in connection with the conditions under which it lay, are not consistent with the said jaw being of any very great antiquity.'

Professor Busk expressed his in the following terms :—

'Mr. Busk desires to add, that although he is of opinion, judging from the *external* condition of the jaw, and from other considerations of a more circumstantial nature, that there is no longer reason to doubt that the jaw was found in the situation and under the conditions reported by M. Boucher de Perthes, nevertheless it appears to him that the *internal* condition of the bone is wholly irreconcileable with an antiquity equal to that assigned to the deposits in which it was found.'

Throughout he questioned the antiquity of the jaw.

The first clause of my verdict, 'that the finding of the human jaw at Moulin-Quignon is authentic,' was intended to absolve the workmen from the imputation of having fraudulently introduced the bone into the bed, when no direct proof could be adduced to support it; while by the second clause it was meant to express my opinion that the bone was not of fossil antiquity, *i.e.* not reaching further back than some date in the modern period. I think it necessary to indicate this clearly, as a wider meaning appears to have been attached to my use of the term 'authenticity of finding,' in the communications which were made to the 'Academy of Sciences' by M. Milne-Edwards and by M. Quatrefages, on the 18th May, than I intended the words to convey. They did not include an admission of the 'authenticity of the jaw' as a true fossil bone. The '*procès-verbaux*' show that from first to last I entertained an adverse opinion on this head.

The necessarily hurried proceedings and unexpected results at the close of the Conference were not favourable to a well considered and deliberate verdict, under the perplexing contradictions of the case. I now believe that I committed an error of judgment in not reserving my opinion on *all* the moot points, instead of reserving it upon three only. I must bear the blame which this admission carries with it, considering how strong my negative convictions, founded upon the

intrinsic evidence, were. I have since carefully reviewed the facts and opinions set forth in the '*procès-verbaux*,' and submitted to the closest examination the numerous suspected flint *haches*, yielded by the 'black seam' and ferruginous gravel of Moulin-Quignon immediately before the Conference and while it sat there; and the result is an irresistible impression, that there is some mysterious complication in the case which remains to be solved. M. Élie de Beaumont, on the occasion when the notes on the conclusions arrived at by the Conference were communicated, on the 18th May, to the 'Academy of Sciences,' by M. Milne-Edwards and M. de Quatrefages, insisted that there was a fundamental error in the view taken of the age of the Moulin-Quignon beds. He denied that they belonged to the *Terrain Erratique*, or *Diluvium* properly so called, but regarded them as '*dépôts meubles sur des pentes*,' or superficial modern deposits, of the age of the peat-beds, in which he would not be surprised if human bones and industrial objects were found ('Comptes Rendus,' 18 Mai, p. 936). At the next following meeting of the Academy, held on the 25th ultimo, the same distinguished geologist is stated to have maintained that these beds were not of an age exceeding that of the *Lacustrine habitations* of the Swiss Lakes, that they might even correspond with certain peat-beds, below which the vestiges of old Roman roads had been met with; and that he would not be astonished if the Moulin-Quignon deposits were found to contain 'Gallo-Roman coins.'

This opinion, if it could be sustained, would appear at first sight to furnish a ready explanation of the contradictory complications of the case. But in reality it does not, for the question is reduced by the evidence to a much narrower issue. I have already dwelt upon the absolutely modern appearance of the suspected flint *haches*, so numerous and so uniform in their character, their rude form, iron-struck facets, high ridges, sharp unworn edges, and fresh unstained surfaces. Had they been yielded by a bed of peat it is conceivable that these signs of freshness might have been retained for an indefinite time; but, with our present lights, is it conceivable that they should have remained for fifteen or eighteen centuries in a highly-ferruginous bed of gravel, freely permeable to water, where every large flint is stained, as a natural result, with iron, and that they should have invariably escaped, even where their substance is whitish and highly porous? Or could they have remained in the 'black seam' uniformly without staining or incrustation, while the flints around them are covered with dendrites? Again, as regards the human jaw. I have stated in the preceding

pages that it presented every physical character of preservation of bones buried within the historical period, and that it wanted all those which are commonly seen in fossil bones. Is it conceivable that this bone could have lain embedded in a mineral layer of manganese and iron, permeable to water, for fifteen or eighteen centuries, and that it should have continued but little altered and so absolutely free from impregnation with these metals that the covering layer of black matrix could be washed off with as much facility as if it had been smeared on during the present year, and that not a single dendrite should have been visible on the washed surface? I have studied fossil bones during upwards of thirty years under various conditions, within the tropics, in the Pliocene and Quaternary beds of Europe, and in the caves; such a case has never come within my knowledge or under my observation. The mute and emphatic eloquence of the persistent intrinsic evidence of the Moulin-Quignon jaw and flints impresses me with a force that far countervails the results of the fallible observation made upon the beds. In this view it seems to me that the real issue, as regards the jaw and the *haches*, is not the geological age of the beds, but when and by what means, within a comparatively recent period, these objects got introduced where they were found? That many of the *haches* are modern fabrications is as certain as a question of the kind can be, without the testimony of eye-witnesses to the act of making them. Several which I now possess from the 'black seam' of Moulin-Quignon and Mautort are of this character. That the suspicions which were expressed in England about the bone were warrantable is sufficiently proved by the fact, that M. Boucher de Perthes, with characteristic candour, has put on record the fact that some workmen of Abbeville, before 1857, had attempted, and for some short time with success, to pass off the skull of a recent horse as a fossil specimen from Menchecourt. They had first embedded it in a paste of chalk and water, and then covered it with the sand of Menchecourt.[1] Although the workmen were absolved, by the decision of the Conference in the present instance, the fact ought to be borne in mind, in weighing the different aspects of this inscrutable case. The trick which was committed once might be repeated again, and those who pass off fictitious *haches* as genuine, would not be scrupulous about a bone.[2]

[1] 'Antiquités Celtiques, &c.,' tom. ii. p. 456.

[2] The 'Quarterly Journal of the Geological Society,' for November, 1863, contained an essay by Mr. Prestwich, entitled: 'On the Section at Moulin-Quignon and Abbeville, and on the peculiar character of some of the Flint-implements recently discovered there,' which concludes with the following paragraph:—

Note.—Further and more deliberate

inquiry, on the part of myself and others, than was possible on the occasion of the Conference at Abbeville, leads me now to revert to my original opinion, and to believe that we were mistaken in concluding on that occasion that no fraud had been practised. In addition to the objections originally urged, I found, on washing a portion of the gravel containing the flint-implements (an experiment contemplated, but unaccountably omitted in May last), the discordance between the mineral condition of the flint fragments and the flint implements to be so great, as to render it evident that the two could not possibly have been subjected during the same time to the same influences. Further, instead of being confined to a special bed and a special level, we found, on a subsequent visit, that specimens had been brought by the men from Épargnette (a bed on a yet higher level and hitherto unproductive); and again, we were given, at Mautort, at a low-level valley-gravel-pit, three flint-implements of precisely the same type and in the same condition as those of Moulin-Quignon; whilst, from the indications given by the men, the specimens would have been taken from a bed of gravel subordinate to the Loess, and not even part of the mass of fluviatile low-level gravel. Our verdict in this case respecting the flint-implements (leaving apart the question of the jaw) will, therefore, I fear, have to be reconsidered. The precautions we took seemed to render imposition on the part of the workmen impossible; still, although it remains undetected, I cannot, with the strong and increased doubts (not one of them since removed) attached to the point, continue to accept the authenticity of these specimens. The essential fact, however, of the occurrence of genuine flint-implements at Moulin-Quignon, the Champ de Mars, and Menchecourt, receives additional confirmation from every fresh investigation, and places M. Boucher de Perthes's important original discovery beyond all doubt.—J. P., *Oct.* 1863.—[Ed.]

XXVI. WORKS OF ART BY PRIMEVAL MAN IN EUROPE.[1]

SINCE the exploration of the Brixham Cave in 1858, an immense impulse has been given all over Europe to the search for, and study of, the material proofs of the antiquity of the human race. The public mind is now craving for information on a subject which a few years back was condemned by the general verdict of men of science, and hardly mentioned except in a whisper. Fresh evidence is being brought to light, day after day, of the most interesting and important character, although not tending to carry man back, in every particular instance, to a period of very high geological antiquity. The south of Europe is the quarter whence the current is now flowing, and the ossiferous caves the springs whence it issues. Professor Busk, in a recent communication ('Reader,' January 30), has given a very clear and excellent account of discoveries made within the last year in a bone-cave in Gibraltar. The materials, not all yet arrived in England, are now under investigation, and give promise of results of high import. But the most interesting additions have been yielded, very lately, by caves in central France, where what may be called works of art, of primitive execution, have turned up in considerable abundance, which prove that savage man, of the unground and unpolished Stone period, was able, in advance of the use of metals, to sculpture on deer's horns, and to grave on stone, figures of quadrupeds his contemporaries that are now extinct in that region. My friend M. Lartet, on behalf of himself and Mr. Henry Christy, his collaborateur in the work, communicated to the Academy of Sciences on the 29th ultimo an account of these relics, which, when exhibited, produced an unusual sensation among the learned Academicians. I purpose now giving a brief sketch of this new and certainly very ancient walk of art, drawn mainly from M. Lartet's paper, which will speedily appear in the 'Comptes Rendus' and from figures of the objects.

The proofs of the remote antiquity of man are derived from two sources:—1, the ancient, or 'quaternary,' river

[1] This communication appeared as a letter in the 'Times,' on March 25, 1864. —[ED.]

gravel-deposits; 2, the ossiferous caves. The former, handled with the severe caution of Mr. Prestwich, carries man furthest back in time, and with the greatest certainty; but it is of the most meagre and restricted character, consisting merely of flint-weapons or implements, hardly ranging beyond a few patterns. Not a single instance has yet occurred of a fragment even of an unquestionably authentic human bone having turned up in these deposits. On the other hand, the evidence yielded by the caves, although less certain as an index of remote time, is infinitely more varied and instructive. It tells us, in certain cases, the division of the human race to which man, the early tenant of the caves, probably belonged; what was his stature and what his physical powers; what the animals which were his contemporaries; what the molluscs, fish, flesh, and fowl upon which he fed; that he cooked his meat by fire; that he extracted the marrow from the bones, and how he did it; how and with what weapons he killed his game; how he flayed and dressed the hides; that he scraped the meat off the bones; that he carefully cut the sinews of his slaughtered deer for harpoon-lines, or for the fibre of sewing thread for his fine-pointed pierced needles; where and in what direction he cut the sinews; what the implements and weapons—in stone, bone, and deer's horn—which he used; what his ornaments; and how he disposed of his dead. It is now beginning to enlighten us on what he was capable of achieving in the way of art, and that in music he had got the initial length of a bone whistle limited to a single note. The cave evidence has been disparaged by cursory observers and light reasoners, upon the grounds that the caves have been occupied at different times, and their contents often disturbed by the latest tenants, thus forming what are called *remanié* deposits. But the shortcomings lay with the objectors themselves. When the profound palæontological knowledge, rare sagacity, and philosophic caution of M. Lartet are applied to what were sources of doubt and embarrassment to them, the supposed difficulties are converted into aids in unravelling the tangled clue, and into indices of ulterior truths. In short, beside the bare fact that primeval man existed during the early 'Fluviatile Drift period in Europe,' all that we know of him—exclusive of the later 'kitchen-middens,' and 'pile-habitations'—is derived solely and entirely from the ossiferous caves.

The caverns which, on this occasion, were the objects of exploration by M. Lartet and Mr. Henry Christy, occur in the department of the Dordogne (the ancient province of

Périgord), and in the arrondissement of Sarlat, in the south-western part of Central France. The most productive localities were the cave of 'Les Eyzies,' in the commune of Tayac, the cave of 'Le Moustier,' and the shelter-recesses under the projecting cliffs of 'Laugerie-Haute,' 'Laugerie-Basse,' and 'La Madeleine,' in the Valley of the Vezère; the rock-formation consisting of indurated chalk. The floor of 'Les Eyzies' cavern is overlaid by a continuous sheet of breccia, composed of a base of cinders and ashes, mingled with charcoal; fragments of bones either in the natural state, or split, scorched, or burnt; outside pebbles; flint-cores with numerous fragments of flint-flakes or knives, invariably of wrought forms, and associated with other implements or weapons fabricated out of reindeer's horns; the whole consolidated in a confused mass, which had never been disturbed since the period of deposition. This was established by the state of the materials and by the fact that in several cases long bones were found with their heads in articular continuity, and vertebræ of reindeer in sequence.

The principal objects of art were as follows:—In 'Les Eyzies,' among numerous fragments of a hard slate, foreign to the district, two plates were found, each bearing an engraved representation of a quadruped. One of them, mutilated by an ancient fracture, presents the fore-quarter of an herbivorous (?) animal, the head of which was apparently invested with horns, so far as the faint lines of the engraving at this part admit of judging. The other bears the figure of a head, with the nostrils sharply defined, and the mouth half opened; but the profile lines of the frontal region are interrupted in consequence of erasure by subsequent friction. On one side and a little in front is engraved the figure of the palm of a large horn, inferred by MM. Lartet and Milne-Edwards, with reserve, to be that of a Moose Deer. These specimens are regarded by M. Lartet as being the earliest known examples of engraving on stone, by primeval man, of the Reindeer period in Europe.

The most striking part of the collection, consisting of sculptured objects, was discovered in the shelter recesses, under the cliffs of La Madeleine, Laugerie-Haute, and Laugerie-Basse, amidst accumulations of bone-refuse and other *rejectamenta*, mingled with an immense quantity of flint-flakes and the cores from which they had been struck off. These spots were evidently the kitchens and manufactories of the ancient savage. The bones indicated the animals on which he fed; being the horse, ox, ibex, chamois, reindeer, birds, fish, &c. The common stag was rare, as were also the boar and the hare. Some detached molar teeth were discovered

of the extinct Irish elk, and also detached plates of the molar teeth of the Mammoth.

Laugerie-Haute would seem to have been especially the locality where flint-implements were made, and Laugerie-Basse that where reindeer horns were converted into spear-heads, harpoons, daggers, arrow-heads, needles, and other implements. Here an enormous accumulation of reindeer horns were discovered, nearly the whole of which bore the marks of a stone-saw, by which pieces had been detached suitable for conversion. Here also were found the principal sculptured objects, some of which, considering the period and the nature of the tools, are marvels both of artistic design and of execution.

The most remarkable is a long dagger or short thrust-sword, formed out of a single horn. The handle represents the body of a reindeer, the parts in fair proportion, and treated with singular skill and art-feeling, in subservience to the use for which it was intended. The forelegs are folded easily under the body; the hindlegs drawn out insensibly into the blade; the salient horns and ears are cleverly applied to the chest by giving an upward bend to the head; and a convenient hollow for the grip of the hand is produced by a continuous curve extending from the rump to the muzzle. M. Lartet remarks that the hand for which it was designed must have been much smaller than that of the existing European races. The weapon was evidently left by the artist-savage unfinished; but, as a design imbued with taste, it will bear a very favourable comparison with Oriental dagger-handles cut in ivory.

Another specimen is described as a handle terminating at one end in a spear-point, and bearing in partial relief the heads of a horse and of a deer, probably reindeer. Others are ornamented with longitudinal and parallel wavy lines, &c. A distinct class consists of palmated portions of reindeer horns, bearing representations of animal forms—some executed in graved lines, others in bas-relief or in high relief. One of these palmations exhibits a figure of a large herbivorous animal which has been conjecturally referred to the Aurochs. Another is supposed to represent an ox, probably *Bos primigenius* (?). The collection, judging by the drawings which I have seen, is very rich in spear-heads, barbed harpoons, arrow-heads, and finely pointed slender needles, drilled with an eye-hole. The harpoons bear a close resemblance to the Esquimaux patterns. On one object the figure of a scaly fish is distinctly represented. The ornaments consist of canines of wolf, incisors of ox and other animals, with ear-bones of horse or ox, all drilled for suspension. One

curious object is the first digital phalanx of a ruminant, drilled to a certain depth by a smooth cylindrical bore on its lower surface near the expanded upper articulation. This is supposed to have been a whistle or call, and a shrill sound is yielded on applying it to the lower lip and blowing into it. Three of these whistle phalanges are of reindeer, one of chamois. One relic of surpassing interest consists of the lumbar vertebra of a reindeer, pierced through and through by a flint weapon, which still remains embedded in the bone, fixed by calcareous incrustation. This is an object of great significance and extreme rarity. Human bones, although found, were very scarce; but M. Lartet has refrained from alluding to them, with a reserve the reason of which is indicated by M. Milne-Edwards. In forming an estimate of the value of the relics of art, the reader will bear in mind that they are the productions of the unpolished and unground 'Stone-period,' the tools employed having been thin chips and delicate flakes of flint. Such at least is the fair inference drawn with our present lights from the negative evidence, not a trace of metal in any shape having been met with in the Dordogne caves. But if primeval man really had made such progress in the conceptions of art, without having yet attained the knowledge of metals, it will be as curious an anthropological phenomenon as are the art objects themselves, which express that degree of luxury which ease, leisure, and comfort beget. Reindeer's horn is notoriously the most worthless and incompact of cervine antlers; it is readily whittled by a knife, which is not the case with stag's horns.

The labours of M. Lartet and Mr. Henry Christy on the Dordogne caves commenced in August 1863. They have been continued ever since, and are still in progress. Valuable and instructive as is the Dordogne collection, it is surpassed in certain respects by another, from the 'Bruniquel Cave,' in the south of France, more recently formed by other observers. The Bruniquel series, it would appear, does not embrace the same range of art, but it is richer in the department of weapons and implements, such as harpoons, spear-heads, &c., which are larger, more numerous, better finished, and in better preservation. These precious materials were offered in succession to the French Government and to the British Museum. 'Perfide Albion' has got them: they are now in the national collection. The result does infinite credit to the zeal, enterprise, and activity of the administration of the British Museum. But the satisfaction which so valuable an acquisition necessarily excites is not wholly unmixed. The investigation of truth is above and beside national predilec-

tion. The 'Bruniquel Cave' series is now divorced from the collections in France, of which it forms a complement, and upon which M. Lartet has been engaged since 1861, when he published his important researches on the Sepulture Cave of Aurignac. Those who take an interest in the advancement of our knowledge of the subject would have congratulated themselves if the Bruniquel materials had been placed in his practised hands, to be included in the work which he and Mr. Henry Christy are about to publish on the remains of man of the 'Cave' period in France.

One circumstance in the case deserves to be generally known. The instinct of a collector is to amass, hoard, and retain. Mr. Henry Christy is the possessor of one of the choicest private archæological collections in Europe. M. Lartet and he explored the Dordogne caverns on a large scale, with the object—first of exhausting the ground, and next of distributing duplicates. They have presented huge slabs of the floor-matrix, containing embedded every variety of object, to all the principal museums in Europe, and selected sets to persons of all countries having a recognized position as labourers in the same field; and this, too, before their own researches were published. In their case a higher impulse extinguished the mere collector's instinct. No comment is required.

P.S. At the meeting of the Academy of Sciences (Feb. 29) a note on the same and cognate subjects was communicated by the Marquis de Vibraye, who has laboured so meritoriously on the ossiferous caves of France.

XXVII. ON THE ASSERTED OCCURRENCE OF HUMAN BONES IN THE ANCIENT FLUVIATILE DEPOSITS OF THE NILE AND GANGES; WITH COMPARATIVE REMARKS ON THE ALLUVIAL FORMATION OF THE TWO VALLEYS.[1]

I. FLUVIATILE DEPOSITS OF THE NILE :—1. GENERAL REMARKS—2. FOSSIL HIPPOPOTAMUS—3. ASSERTED DISCOVERY OF HUMAN BONES—4. ANALOGY OF THE FLUVIATILE DEPOSITS OF THE NILE WITH THOSE OF THE GANGES —II. FLUVIATILE DEPOSITS OF THE GANGES :—1. PHYSICAL FEATURES OF THE VALLEY OF THE GANGES—2. MAMMALIAN FOSSILS—3. FOSSIL MOLLUSCA—4. GENERAL INFERENCES—III. ANTIQUITY OF MAN IN INDIA : CONCLUSION.

§ I. Fluviatile Deposits of the Nile.

1. *General Remarks.*—The object of this communication is to bring together the few instances on record of the occurrence of Mammalian fossil remains in the Valley of the Nile, and to institute a comparison between the Nilotic alluvial deposits and those of the upper part of the Valley of the Ganges which have come under my own observation. Fossil human bones have, according to certain statements, been met with in both of these sub-tropical valleys; and it may be useful, at the present time, to consider to what general inferences the cases lead, as a guide to future observation.

The explorations conducted by the French authorities in Algeria have brought to light numerous remains of *Hippopotamus* and of other Mammalia, extinct or living, from the later deposits of that part of Africa; but it is not a little singular that the Valley of the Nile has heretofore been so unproductive, considering the stream of intelligent travellers that flows up the river every season from Alexandria to the Cataracts, and the not insignificant number of accomplished explorers, German, French, and English, who have traversed

[1] The author was engaged in writing this paper immediately before his fatal illness. What was completed was published after his death in the 'Quarterly Journal of the Geological Society' for November 1865, from which it is now reprinted.—[Ed.]

the country, as high as the confluence of the 'Blue' and 'White' rivers, and latterly above it. The alluvial deposits along the banks appear in many places to be developed in great force; and the lowermost present characters which would refer their origin back to a high antiquity. But although fossil wood and shells of land- and fresh-water Mollusca have been very generally met with in these deposits, Mammalian remains have been but very rarely observed, and the instances on record only cursorily described. These will be referred to in the sequel. Any case which is calculated to direct attention to this neglected walk of observation deserves to be noticed.

2. *Fossil Hippopotamus.*—The specimen sent to the Geological Society by Dr. Leith Adams consists of a fragment of the left maxillary, containing *in situ* the two last upper true molars of a very large Hippopotamus. Of these the penultimate is far advanced in wear, the crown-divisions having been ground down to the common nucleus of ivory, leaving only two small islets of enamel upon the depressed disc. The last molar is but partially worn, the two pairs of trefoil comprising the crown-surface being distinct both in the longitudinal and transverse directions.

The molar teeth present the ordinary characters of the existing Hippopotamus of the upper part of the Valley of the Nile and Senegal, but in size they equal those of the great extinct form of Europe, *Hippopotamus major* of Cuvier. I have compared them with the corresponding molars of the largest specimen of the living species that has come under my observation, being the huge male skull No. 3,405 of the Hunterian collection, in the Museum of the Royal College of Surgeons, and with a set of specimens of *H. major* from the Val d'Arno, presented by Mr. Pentland to the British Museum.

The following are the comparative dimensions:—

	H. amphibius No. 3,405, H. Col.	H. major No. 28,790, Br. Mus.	H. major No. 28,789, Br. Mus.	H. major A palate, Br. Mus.	Kalábshee specimen	H. major No. 28,785, Br. Mus.
	in.	in.	in.	in.	in.	in.
Joint length of the two last true molars	4·0	4·0	4·3	4·3	4·3	4·65
Length of penultimate . .	1 95	2·0	2·3	2·2	2 25	2·5
Width of penultimate	2·0	2·2	2·1	2·3	2·2	2·2
Length of last molar	2·1	2·1	2·1	2 2	2·2	2·2
Width of last molar	2·1	2·15	—	2·3	2·15	2·25

From these figures it will be seen that the molars in the Kalábshee specimen are as large as the majority of those of

the extinct form with which it was compared, and that of the latter there is only one, No. 28,785, in which the dimensions are greater, while the Kalábshee specimen slightly exceeds the proportions yielded by the existing Hippopotamus. It is at the same time to be remarked that the latter is as large as No. 28,790 of *H. major*; and it has still to be shown that the bones of the skeleton of the latter form surpass those of the living species more than do the fossil bones of *Bison priscus* those of the existing Aurochs, which is generally regarded as being of the same species.

In *H. major*, the basal cingulum of the molar is commonly more salient and crenately lobed than in those of the living species. The Kalábshee specimen in this respect agrees with the latter form; but it is at the same time to be observed that the cingulum is not well preserved in the Nile fragment.

The evidence yielded in the present case is too limited to warrant any well-founded opinion regarding the species; but, notwithstanding the large dimensions of the molars, I have failed to detect any diagnostic characters which would justify the separation of the Kalábshee specimen from the Senegal variety of the living *H. amphibius*. It is inferred to have been yielded by a large and old male. In mineral condition it appears to be as well fossilized as specimens of *H. major* from the Val d'Arno and Auvergne. The cancelli of the bone are filled throughout with matrix resembling Nile mud; the ivory of the molars has lost a large portion of its gelatine. Professor Busk, who has analyzed the specimen, found that the earthy salts of the bone yielded a very large proportion of carbonates; but he failed to detect more than a very faint trace of fluorine, so commonly met with in bones of great antiquity.[1] A calcareous crust covers the enamel of the teeth. Dr. Leith Adams does not indicate, in his paper, the precise stratum near Kalábshee out of which the fragment was exhumed, this being a point of much importance in the case.

Geologists may be reminded that, although rarely observed, this is not the first instance in which fossil or sub-fossil remains of *Hippopotamus* have been procured from the Valley of the Nile. Dr. Rüppell brought to Europe, in 1827, the remains of a species of Hippopotamus from above the Cataracts. They were deposited in the Senckenberg Museum at Frankfort, and indicated a species in size between *H. amphibius* and the existing small *H. Liberiensis* of St. Paul's

[1] The following gives Professor Busk's analysis:—

Organic matter	7·5
Earthy carbonates	57·5
Phosphates, &c.	35·0
Iron	a trace.
Fluorine	scarcely an indication.

River, in Western Africa. I had an opportunity of examining them in 1849; and in the synopsis which I contributed to Dr. Morton's account of the Liberian Hippopotamus, the species was referred to, under the provisional name of *H. annectens*, as intermediate between the two living species.[1] It may prove to be of *H. Pentlandi*, the extinct species prevailing in Sicily, Malta, and Candia, which was then unknown to me.

Of *H. major*, the huge fossil form of the Val d'Arno and Auvergne, abundant remains have been found in deposits, either Pliocene or Quaternary, in Algeria. A fine series of specimens derived from that region is exhibited in the Museum of the École des Mines in Paris.

3. *Asserted Discovery of Human Bones.*—The next case of Nilotic fossil remains is of still higher interest, being the asserted discovery of human bones in one of the conglomerate or older beds of the Nile-valley alluvia, at a time when the antiquity of the human race did not engage the attention of men of science as it does at the present day. In Leonhard and Bronn's 'Jahrbuch' for 1838 a series of letters appeared, in which Russegger gave some account of the results of his explorations then in progress in Nubia and Sudan. In one of these letters, dated Sennaar, March 23, 1838, he describes the structure of the alluvial banks of the Blue Nile from Khartoom up to Sennaar, and thence to Roserres, and adds that, 'In the alluvia of the Blue Nile at Duntai we found human bones. The structure of these bones was perfectly preserved, but the animal matter had disappeared. Their surface was polished and of a blackish-brown colour; the substance very hard, but not yet petrified'[2] (Jahrbuch, 1838, p. 403). In the second volume of his travels, published in 1843, Russegger enters at greater length into the details of the case, and states that the alluvial formation of the Blue Nile, from Khartoom to Sennaar, consists of freshwater beds thrown down by the river itself, and that, regarded as a whole, they are divisible as follows, from above downwards:—

1. Ordinary fluviatile mud, the result of modern periodical inundation, analogous in its external characters to the Nile-mud of Egypt, and containing embedded nodules of calcareo-argillaceous concretions (nodular kankar?).

2. Friable, fine and coarse conglomerate, composed of

[1] 'Observations on a new living Species of Hippopotamus, *H Liberiensis*, of Western Africa.' By Dr. Morton, Philadelphia, 1849, p 8. [See *antea*, p 404. —Ed]

[2] In den Alluvionen des blauen bei Dundai fanden wir Menschenknochen. Das Gefuge der Knochen war vollstandig erhalten, der Thiermaterie aber zerstort. Die Aussenflache war glanzend und schwarzbraun gefarbt, die Masse sehr hart, aber noch nicht versteinert.'

quartz-grains and pebbles, cemented by ancient mud, forming a kind of sandstone-grit, and yielding calcareous and marly concretions.

3. Ancient Nile-mud, indurated, and containing embedded iron shot clay, siliceous limestone, &c., full of calcareous and marly concretions in the ferruginous portions.

4. Fine and coarse quartzose conglomerate, with the materials united by ancient Nile-mud and calcareo-argillaceous cement, very hard, used as a building stone, and containing embedded masses of saline clay and of ordinary clay and marl, full of clay ironstone, ferruginous sandstone, and of calcareous and marly concretions.

5. Freshwater limestone (travertine, or slab kankar?) of a dark-grey colour, hard and sonorous, occasionally having a marly appearance, with here and there a tendency to a concentric and generally crystalline structure.

The beds are described as horizontal, of very variable thickness, attaining sometimes, in Nos. 1, 2, and 3, as much as five or six fathoms (Jahrbuch, 1838, p. 408). According to Russegger, with the exception of the uppermost deposit, they contain very generally fossil vegetable remains, chiefly the wood of Mimosas (*Mimosa Nilotica*) and stems of *Asclepia* (*Calotropis*) *procera*; the former are either converted into lignite or have their core exhibiting a concentrically disposed and radiating crystalline structure, derived from the embedding matrix; the latter have the bark preserved, but the spongy core occupied either by calcareous matter or conglomerate. These alluvia presented very commonly shells of the Mollusca now living in the waters of the Nile, both bivalves and univalves, together with some land species. Among the most common was *Ætheria Caillaudi*, occurring frequently in heaps or oyster-banks, together with species of *Unio*, *Iridina*, and *Anodonta*. In the alluvium of Sennaar he found *Ampullaria ovata* and a species of *Helix*. He adds, that *Ætheria Caillaudi* was also abundant in the deposits of the White Nile.

M. Lefèvre, writing at the same time, confirms the observation of Russegger about the occurrence of the conglomerate. 'Near Khartoom, on the Libyan side, you meet on the *redans* of the White Nile with a modern conglomerate composed of fragments of sandstone united by a calcareous cement, either deposited by the water of the river or filtered through the alluvial soil. This concretionary deposit is exhibited equally on the banks of the Blue Nile, and it is well seen on either side where the banks are perpendicular.' He adds that the alluvial escarpment is nowhere higher than from 50 to 56 feet.

In his 'Reisen,' Russegger describes the occurrence of the human bones at Duntai in terms somewhat different from those employed in his 'Briefe' in the 'Jahrbuch.' 'The freshwater alluvia occurring at Karkodije and Seru extend, with the slight modifications already indicated, up the Blue River as far as Roserres, forming a hillocky alluvial track; and in this instance I must observe that in the ancient mud-conglomerate of Geivan we found portions of Mimosa-wood completely converted into lignite, and, at the village of Duntai, near Seru, calcined (verkalkt) human bones in the incipient stage of bitumenization.[1] A kind of bitumen, or rather highly bituminous lignite, also occurs, although sparingly, at Geivan, and, according to my observation, only in small elongated nodular pieces, which in their transverse fractures display a concentrically laminated structure, resembling the annual growth of wood, and burning with a brief flame only, but emitting a very smoky and bituminous odour.' On neither occasion does Russegger specify what these fossil human bones were, nor am I aware that any detailed identification of them has been published. But the case is of sufficient importance to demand the attention of future explorers of the Nile valley to a walk of observation which may yield results of high importance. Captain Grant informs me that neither Captain Speke nor he ever met with fossil bones along their route. Besides the asserted human bones at Duntai (about halfway between Sennaar and Roserres), Russegger mentions, cursorily, that in the conglomerate of Woadd Medineh, also on the Blue Nile, he encountered a kind of sandstone mass containing bones, which he took to belong to the foot of a young camel. Dr. Murie, who accompanied Mr. Petherick on his return to Soudan, has shown me specimens of an alluvial fine grained siliceous grit or conglomerate from the White Nile, above Khartoom, which is full of shells of *Cyrena fluminalis*. The observations of Russegger, Mr. Leith Adams, and Dr. Murie agree as to the abundance of the shells of Mollusca in the Nilotic alluvia, mud, or conglomerate, from the neighbourhood of the First Cataract upwards, and along the course both of the Blue and White Rivers—oyster banks of *Ætheria Caillaudi* occurring throughout.

4. *Analogy of the Fluviatile Deposits of the Nile with those of the Ganges.*—In some of the phenomena observed by all the

[1] The original passage stands thus:—'Und ich glaube diessfalls nur bemerken zu mussen, dass wir in dem ältern Flussschlamm-Konglomerate bei Geivan Stucke von Mimosenholz, das ganz in Braunkohle umgewandelt war, und am Dorfe Duntai bei Seru Menschenknochen fanden, verkalkt und im Zustande einer beginnenden Verkohlung.' (Russegger, 'Reisen,' Band ii. pt. 2, p. 717.)

travellers above named, there is a striking analogy between the alluvial deposits of the Valley of the Nile and those occurring along the banks of the Ganges and Jumna rivers, in the great alluvial valley of Hindostan. Of these the most obvious is the great abundance of argillaceo-calcareous concretions, forming an impure kind of travertine, and in the lowermost beds horizontal deposits of more or less extent, composed of the same kind of material. Russegger constantly alludes to their frequent occurrence, both in the conglomerates and in the indurated sand- or mud-deposits, in the form of nodular concretions, varying in size from a pea up to a quarter of a cubic foot, and having their centres occasionally occupied by drusy cavities lined by crystals of carbonate of lime. The lowermost bed, No. 5 of his section, consisting of a hard dark-grey clinking limestone, appears to be a modified kind of the same calcareous deposition. The nodular form of these concretions is familiar to English observers in the 'Race,' which so thickly studs the sections of the brickearth-pits in many localities in the Valley of the Thames.

§ II. Fluviatile Deposits of the Ganges.

1. *Physical Features of the Valley of the Ganges.*—The vast expanse of the plains of Hindostan consists of a fundamental deposit of very ancient fluviatile sediment, which is developed in great force, but varying in its detrital characters as we follow the course of the rivers down to the sea. The valley is longitudinally traversed, after their escape from the Himalayah Mountains, by the Ganges and Jumna, which unite at Allahabad. The segment, the Doab, constituting the upper division of the plains of Hindostan, is that to which the remarks which follow apply. It is comparable in some respects to the tract through which the 'Blue' and 'White' Niles flow in the lower part of their course to their junction at Khartoom. The Ganges at Hurdwar, where it debouches from the Sewalik hills, is, according to the results given by Sir Proby Cautley, 974 feet above the level of the sea, and at Allahabad 269 feet, after running a course in a straight line of 472 miles, giving an average fall of nearly 18 inches per mile. From Allahabad to Rajmahal in Bengal, near the top of the modern delta, the average fall, according to the instructive table given by Mr. Fergusson, amounts to about 6 inches along a stretch of 385 miles. The Jumna river, where it escapes from the Sewalik hills at Rajghat, is a little more elevated; but it runs a nearly parallel course at no great distance from the Ganges, and in the inclination of its bed and other physical phenomena it resembles that river

so closely that in the present sketch it is not necessary to dwell on the points of difference.

Although the average inclination of the Ganges between Hurdwar and Allahabad is about 18 inches per mile, it increases considerably as we ascend the river. Thus the fall, which in the distance of 122 miles between Cawnpore and Allahabad diminishes to 13 inches, attains in the mean of the 350 miles above it 18·3 inches, and so on upwards as we ascend. The sedimentary deposits and transported materials vary, as a general rule, in the same ratio. The northern slope of the Sewalik hills is overlain with a thick mass of boulder-gravel, inclined at a considerable angle, and conformable to the sandstone strata of which this Miocene range is composed. The boulders vary from a few inches to upwards of a foot in diameter; they have undergone the utmost amount of attrition, being constantly smooth and rounded into more or less of a globular form. Their origin is distinctly shown, as they are invariably composed of some of the rocks which form the intramontane portion of the nearest river-channel, transported by violent torrential action during the protracted season of flooding. Modern boulder-dejections of precisely the same character, and derived from the same rocks, are seen in progress of formation where the rivers debouch into the plains, constituting rude deltas, having a flattened conoid surface, the base of which is ultimately confounded with the plains. This gravel and boulder alluvium disappears from the surface and along the beds of the rivers within a short distance from the hills, and is replaced by a sand or clay alluvium, which becomes the prevailing deposit down to the confluence of the two rivers at Allahabad. It marks the boundary of the habitat of some of the characteristic vertebrate forms of the Ganges, such as the Gharial Crocodile (*Gavialis gangeticus*) and the freshwater Porpoise (*Platanista Gangetica*), which ascend to within thirty or forty miles of Hurdwar, where the gravel-beds and rapids of the stream terminate; while the *Crocodilus bombifrons* is met with in the dhoons or longitudinal valleys which lie between the Himalayahs and the Sewalik hills.

The rivers which traverse the alluvial plain of Hindostan have produced the usual effects of powerful fluviatile action operating during a long lapse of ages, aided by movements of upheaval or depression, distinct evidence of which has been brought to light by deep borings in the delta. The two principal streams have gradually scoured their channels down through the ancient alluvium to a depth of from 100 to 150 feet below the level of the adjacent plains, thus exposing a very instructive section of great extent. At the lower part

of this section the rivers, as in the case of the 'Blue' and 'White' Niles, have intersected horizontal beds of argillaceous or arenaceous travertine, or banks of aggregated nodular kankar, which frequently form dangerous subaqueous reefs or bars, obstructing boat-navigation. The Government of India undertook in 1828 a series of operations, which extended over seven or eight years, for the removal of these and other obstacles from the bed of the Jumna, in which they are most prevalent. These were conducted by highly instructed officers of the Bengal Engineers, one of whom, Captain Edward Smith, published an account[1] of the most striking facts which were observed on the occasion between Agra and Allahabad. The upper half of the section, consisting of beds of sand and clay, contained throughout, in more or less abundance, the impure calcareous concretions called nodular kankar. Near the base of the lower half these calcareous deposits were developed in much greater force, sometimes forming strata of rock kankar, from 1½ foot to 2 feet thick, with a thinner bed of clay interposed. At one point, Burlót, below the junction of the Chambal river, where the bank is precipitous and 100 feet high, a stratum of rock kankar, in the form of a granular concrete 2 feet thick, was observed 60 feet above the lowest level of the stream. But the most ordinary condition of the material is the concretionary, in the form of nodular botryoidal stalactite or ramified kankar. In some places the concretions, closely compacted and connected by veins, are disposed in horizontal strata in clay, at 10 or 12 feet above the level of the stream; in others the kankar presents itself in vertical seams in the scarped front of the bank, or it ramifies in every direction through the clay, literally lacing it together; and occasionally ancient surfaces of sun-cracked clay, where denuded, are seen with the fissures filled with septarian plates of the same material. At one point, Kareem-khan, *slab-kankar*, used for building-purposes, and consisting of fine sand solidified by carbonate of lime, is quarried at shallow depths from under the bed of the river. Captain Smith (from whose memoir the above particulars are for the most part drawn) has given an excellent series of highly instructive sketches, showing the various modes in which the kankar occurs along the banks of the Jumna.

2. *Mammalian Fossils.*—Fluviatile shells were either extremely rare, or they escaped the notice of individuals who were not familiar with this walk of observation. Only two instances are recorded—one an open *Unio*, embedded in a

[1] Journ. Asiat Soc Bengal, vol. ii. p 622 (1833).

perforated sandy clay near the level of the river; the other, marks of shells in the granular concrete of rock kankar, found at 60 feet above the stream, at Burlót. But fossil bones were encountered in great abundance. In one case, unconnected with the operations above referred to, the skeleton of a fossil Elephant was discovered in a bed of clay deposited on a bottom of kankar, overflowed by the water of the river during the floods, about three miles above Calpee. Some of the remains were forwarded in 1828 to the Asiatic Society of Bengal. In another case the skeleton of an Elephant, forming a great mass, was observed by Mr. E. Dean lying amongst an immense assemblage of kankar deposits, contained in the lowest stratum of clay intersected by the river, under the village of Pauch-kowrie, near Korah Jehanabad. The stratum forms a bank, there elevated 4½ feet above the highest flood-mark, and 80 feet below the summit of the cliff; and abreast of it the Jumna has deepened its bed 25 feet. Numerous other organic remains occurred in the masses of other deposits surrounding the skeleton, but the precise kinds were not ascertained. In a third case, a very large tusk of an Elephant, stated to have been 8 inches in diameter, was discovered lying beneath a plate or slab of kankar in removing obstructions from the bed of the Jumna, near Adháe. The ivory was fossilized, but not petrified; and the Sepoys engaged on the work broke it up, and burnt it for pipeclay to whiten their belts.

The great mass of the fossil bones which were discovered during the first five years of the operations were unfortunately lost, having been heedlessly thrown back into the deep channel; and only those subsequently met with were preserved. They were found either embedded in the lowest deposit of stiff clay, or in the shoals of kankar. Of the latter, some were unquestionably of very modern origin, since they yielded a sword and portions of a sunken boat. Their mode of formation is obvious. Nodules of kankar and fossil bones, detached from the alluvial cliffs by various denudating agencies, are swept on by the floods until they meet with some obstruction, where they collect and get commingled with extraneous materials of modern origin, and the whole become solidified in a concrete, formed by the calcareous mud of the kankar, aided by lime derived from the waters of the river. They are therefore *remanié* deposits, wholly distinct from the original kankar and fossiliferous clay-beds through which the stream has cut its way down. The difference was clearly made out by the engineer officers employed in the removal of the shoals, who distinguished the two by the names of *natural* and *artificial* kankar.

The great majority of the bones were well fossilized, and in most cases petrified.[1] Species of the following genera were determined:—*Elephas, Hippopotamus, Sus, Equus, Bos, Cervus, Antilope,* small Rodents, *Gavialis Gangeticus,* and freshwater Chelonians. The specimens were commonly too mutilated, and the materials then available for comparison too defective, for certain specific determination in all cases: but among them I identified molars of the extinct *Elephas Namadicus*; a lower jaw with teeth, and a perfect astragalus, of the true Indian Hippopotamus, *H.* (*Tetraprotodon*) *Palæindicus*; a fragment of a jaw of the great fossil Buffalo of the Nerbudda, *Bos* (*Bubalus*) *Palæindicus*; and jaws undistinguishable from those of the living Gharial Crocodile. Both Captain Smith and Mr. Dean, aided by medical officers more or less versed in anatomy, thought that they had encountered human bones among the Jumna fossils; and this opinion was published at the time in an Indian scientific journal; but the identifications were negatived by Dr. Pearson and Dr. Evans, the curators of the Museum of the Asiatic Society of Bengal; and on submitting the specimens to a close examination several years afterwards, I could discover no determinable human bones among them.

Another observation was made by Captain Smith, upon which he was professionally competent to give an opinion with authority—namely, that some of the fossil bones 'were dug from depths of 6 to 18 inches in the firm shoal, which is composed of substances (*sic*), kankar, bricks (vitrified clay ?), more or less rolled and cemented by mud and clay. The circumstance is explicable on the modern accretion of some of the kankar shoals above referred to, without involving a great antiquity to the fragments of burnt clay.'

Of the fossil genera above named there are three well-determined species, which are of much significance in the history of the Doab alluvia. The first is *Elephas Namadicus*, an extinct form characteristic of the Pliocene fauna of the Nerbudda. It belongs to the same group, *Euelephas*, as the existing Indian Elephant; but it is broadly distinguished from that species, and from all other known species, by a very marked peculiarity in the form of the cranium, in addition to dental and other characters. Among the vast quantity of Miocene Proboscidean remains yielded by the Sewalik hills not a trace of *Elephas Namadicus* has ever come under my

[1] Mr. James Prinsep examined one of the fossil bones of the Jumna, which on a rough analysis yielded the following results:—

Phosphate and carbonate of lime	17·5
Water	6·0
Red oxide of iron with alumina	76·5
	100·0

observation. But I have seen perfect skulls of the species from richly fossiliferous fluviatile deposits of Southern India.

The second important species of the Doab alluvium is the huge ruminant, *Bos* (*Bubalus*) *Palæindicus*, also characteristic of the Nerbudda fossil fauna. This form is closely allied to the existing wild Buffalo, or *Arnee* of the Indian forests, from which the domestic animal appears to have sprung. Not a trace of it, or of any species of the same subgenus, has yet been observed among the Sewalik fossil Mammalia; nor has its range in the fossiliferous beds of Southern India been as yet accurately determined. But, in indicating these distinctions of the Miocene and Pliocene faunas, it is important to remember that the rule is not absolute. I ascertained the presence of the Miocene Proboscidean, *E.* (*Stegodon*) *insignis*, of the Sewalik hills, among the Pliocene Mammalia of the Nerbudda, where it was accompanied by a species of the Miocene Hippopotamus, *H.* (*Hexaprot.*) *Namadicus*. The fossil Buffalo here referred to existed in the same Nerbudda fauna along with a huge Taurine species, *Bos* (*Urus*) *Namadicus*, of which no close representative has been discovered among the existing Indian *Bovidæ*. It differs alike from the *Gour* and *Gayal*. Of it also no trace has been detected among the Sewalik Mammalia.

The third fossil species, *Hippopotamus Palæindicus*, is, perhaps, the most important in its indications. It belongs to the subgenus *Tetraprotodon*, characterized by four incisors, like the two African living species, and the European fossil species, *H. major* and *H. Pentlandi*; but it is essentially distinguished by constantly having the middle incisors smaller than the outer pair, being the converse of what occurs in the other. No well-authenticated case has as yet been established of any fossil *Tetraprotodon* in Miocene strata. A quadruped so remarkable for its size, form, and habits must everywhere have forcibly impressed itself on the attention of mankind; and, struck with the close resemblance of the Nerbudda fossil Buffalo to the existing species, the question arose with me, May not this extinct Hippopotamus have been a contemporary of man? and may not some reflection of its former existence be detected in the extinct languages or ancient traditions of India, as in the case of the gigantic Tortoise? Following up the inquiry I ascertained from the profound Sanscrit scholar, Rajah Radhakanta Deva, that the Hippopotamus of India is referred to under different Sanscrit names of great antiquity, significant of 'Jala-Hasti,' or 'Water-Elephant,' in the 'Amaracosha' and 'Subda-ratnavali.' This view is confirmed by the opinion of two great Sanscrit scholars, Henry Colebrooke and H. H. Wilson. The

former, in his annotations on the 'Amaracosha,' interprets the words 'Gráha' and 'Avahára' as meaning Hippopotamus; and the latter not only follows this version, but gives two other words, 'Kariyádus' and 'Vidoo,' which he supposes to signify the same animal. It is therefore in the highest degree probable that the ancient inhabitants of India were familiar with the Hippopotamus as a living animal; and it is contrary to every probability that this knowledge of it was drawn from the African species, imported from Egypt or Abyssinia. Assuming that the quadruped was a contemporary of man in India, a very complex question is involved, which is beyond the scope and limits of the present communication, namely, the ancient vocables above referred to as the groundwork of the argument being of Aryan derivation. Did the Aryan emigrants see the animal living on the northern rivers of India, or was their knowledge of it derived from the traditions of the more ancient indigenous races whom they subjugated or displaced? After reflecting on the question during many years, in its palæontological and ethnological bearings, my leaning is to the view that *Hippopotamus Namadicus* was extinct in India long before the Aryan invasion, but that it was familiar to the earlier indigenous races. I may add that remains of the species have nowhere as yet been observed in recent or comparatively modern deposits in India; they have only been met with in a petrified condition, deep in the alluvium of the Jumna, or in ancient deposits in the Valley of the Nerbudda.

3. *Fossil Mollusca.*—I have already stated that our information regarding the Mollusca occurring in the ancient alluvium of the Jumna is almost *nil*; until lately, this would have applied to the fossil shells of what I have designated throughout as the Pliocene deposits of the Valley of the Nerbudda. But the operations of the Geological Survey of India have already extended to that district; and I have been favoured with a communication from Professor Oldham, dated January 8, 1858, in which he informs me that the evidence as to the age of the formations is now becoming tolerably conclusive. A large collection of shells, comprising a considerable assemblage of species and a great quantity of individuals, all proved to be of existing forms.

But there was this remarkable in the group, that of many of the commonest living species some were exceedingly rare, or even absent. Of *Planorbis Coromandelianus*, one of the most prevalent Indian species and abundant in the Nerbudda district, only two specimens were found in the fossil state; while of *Melanidæ*, *M. variabilis*, and *M. spinulosa*, also common living forms, were not met with. The species, none

being marine, in all amounted to twelve or thirteen. In designating the formation as Pliocene, which I have done during many years, I have been guided by the indications of the Mammalian fauna, as intermediate between the Miocene of the Irrawaddi, Perim Island, and the Sewalik hills, and that of the existing period.

4. *General Inferences.*—I shall now briefly indicate the inferences to which the observations on the section of the Jumna lead.

1. That the Doab alluvium, intersected by the Ganges and Jumna, consists of fluviatile sedimentary deposits, the inferior portion of high antiquity.

2. That there are no indications of its being anywhere overlain by deposits resulting from marine submergence.

3. That during the progress of alluvial deposition the area now constituting the plains of Hindostan was probably subject to movements of upheaval and depression, analogous to or corresponding with those which have been demonstrated to have occurred in the delta of the Ganges.[1]

[1] MS. Note written by Author in 1844. 'The conditions under which Oceanic deltas are formed, upon the verge of the sea, preclude the occurrence of sections, so as to show how the details of the daily progressing strata are arranged. Our knowledge in such cases is ordinarily limited to the superficial banks of the rivers and creeks, through which the tidal currents scour. Happily, the desired information in regard to the delta of the Ganges has in some measure been supplied by boring operations, which have of late years been carried nearly 500 feet below the level of Calcutta, the results having been carefully recorded in the Indian journals. These borings were begun as far back as 1804, and have been repeated at different periods, the last and deepest excavation having been carried on between the years 1836 and 1840, under the superintendence of a committee of engineers.

'Calcutta is situated in the midst of the delta of the Ganges, upon the banks of the Hooghly, within the range of the tidal current. The surface soil consists of ten feet of fine mud or inundation sediment, which is succeeded in the descending order by a bed of blue adhesive clay, 40 feet deep. The lower portion of this clay abounds in decayed vegetable matter, part of which is in the condition of peat mixed with fragments of *red-coloured* wood, hardly altered, which Dr. Wallich was enabled to identify with the Soondree of the creek forests. Next follows a bed of ten feet thick of the concretionary argillaceous limestone, which, under the name of "kankar," occurs abundantly in many parts of India, in the form of irregular nodular masses. Then succeeds a bed of green siliceous clay, 15 feet thick, the lower portion of which also furnishes kankar-nodules. At 75 feet below the surface, variegated sandy clay begins, and continues to a depth of 45 feet. This is succeeded by thin beds of clay marl, loose friable sandstone, and a sandy clay abounding in weathered fragments of mica-slate, and waterworn nodules of hydrated oxide of iron. At 175 feet a soft conglomerate, 10 feet thick, is met with, consisting of gravel cemented by a clayey matrix, together with sharp angular fragments of quartz and felspar, larger than peas, and resembling in every respect the debris of granitic rocks which have suffered little attrition by transport from a distance. The gravel passes gradually into an indurated ferruginous sandy clay abounding in scales of mica, which continues with little variation through a depth of 18 feet. A thin stratum of soft sandstone occurs next, succeeded by beds of sand and sandy clay extending with great uniformity of character through a depth of 172 feet. The lower half of the humerus of a ruminant, apparently a species

4. That the fossil remains occurring in the undisturbed banks of clay and kankar, at the bottom of the section, are of the same age as the deposits in which they occur.

5. That the ancient fossil Mammalia of the Gangetic valley belong to the Pliocene fauna of the Nerbudda, as distinguished from the Miocene fauna of the Sewalik hills.

6. That of the Jumna fossil Crocodiles, some belong to species which are now living; and that of the extinct Mammalia, some were probably contemporaries of man.

7. That no trustworthy cases of the occurrence of very ancient human bones or industrial objects have yet been established from the sections of the Jumna and Ganges, but that they may be looked for on a more careful and extended search.

8. That in the great abundance of calcareous concretionary deposits there is an analogy between the alluvial beds of the valleys of the Ganges and Nile; but that in the property of vertebrate remains, the latter, in so far as it has been explored, is a remarkable contrast to the former.

§ III. Antiquity of Man in India.

1. *Introduction.*—In discussing some of the speculative points which have been raised in this paper, I have introduced topics which are not usually brought before the Society. But I make no apology. Geology has never disdained to

of Deer, and of the size of the common *Cervus porcinus* of India, impregnated with hydrate of iron and retaining but a slight trace of animal matter, together with portions of the bony shell of a species of Trionyx, resembling those now found existing in India, were brought up from the lower part of this sand at depths of 350 and 375 feet below the surface. The sand is followed by a bed of blue clay full of freshwater shells, which from their fragmentary and incoherent condition could not be specially identified. Under this lacustrine deposit, another "dirt bed" or dark-coloured clay occurs, composed almost entirely of decomposed or decayed woody matter, mixed up with argillaceous earth, extending through a depth of 10 feet. At this point, about 400 feet below the surface, a remarkable and abrupt change takes place in the sedimentary character of the strata of the delta. Immediately below the clay an enormous accumulation of gravel is met with, consisting of boulders and large rounded pebbles of quartz, felspar, limestone, and other primitive rocks, among which a rolled fragment of *vesicular basalt* (?) is stated to have been found. From the upper portion of this gravel, near its junction with the superincumbent clay, fragments of excellent coal were brought up, a large field of this mineral occurring in the Burdwan district, 70 miles above Calcutta. Fragments of lignite, resembling that found in the adjacent hilly district of Cuttack, together with caudal vertebræ, attributed to a Lacertine or small Crocodile form, and Chelonian remains referable, like those from the superincumbent sand-beds, to species of the freshwater genus Trionyx, were yielded at different depths by the gravel. Near the bottom of the bore, the auger passed through a log of waterworn decayed wood, uncarbonized, and so little altered as to resemble in every respect "fragments occurring in the modern alluvium of the Soonderbuns." The bore terminated at 481 feet beneath the surface by the auger becoming unfortunately jammed, the gravel still continuing of the same character, although already penetrated to a depth of 85 feet.'—[Ed.]

draw upon any department of human knowledge that could throw light on the subjects which it investigates. Cuvier, in the 'Discours Préliminaires,' exhausted the records and traditions of every ancient people in search of arguments to support the opinion that the advent of man upon the earth dates from a comparatively late epoch. At the present time the whole aspect of the subject is transformed. The science is now intimately connected with archæological ethnology, in searching for evidence of the hand of man in the oldest Quaternary fluviatile gravels of Europe. In other continents, under different physical conditions, it may be possible to interweave the indications of language and misty tradition with the more certain results of palæontological research, and thus to aid us in arriving at that 'speck now barely visible in the distance, which is our goal to-day, and may be our starting-point to-morrow.' I shall, therefore, not hesitate to enter upon a complementary portion of the same walk of investigation which is intimately connected with the thread of the preceding speculations.

[A portion of the paper is here omitted, as it corresponds with a passage in the historical essay on 'Primeval Man,' p. 573 to p. 579.—ED.]

The large question which these reflections concern is at the present time followed up with the keenest intelligence and with the closest scrutiny over a large portion of Europe. But in the tropical regions, which promise to be the most fertile of results, the ground has been barely broken. The observations of Russegger in the Valley of the Nile would seem to have fallen into the oblivion which shrouded the shrewd observations of Frere on the Hoxne implements, until they were brought to light by the researches of Mr. John Evans. In India also the inquiry, begun so auspiciously nearly thirty years ago, appears to have stagnated in later days, and to require a fresh impulse. The important discoveries of Captains Speke and Grant will assuredly attract explorers, until the affluents which feed the lake out of which the White Nile flows are traced to their sources. It is incredible that that great river should run for fifteen or seventeen hundred miles, often through alluvial deposits, ancient and modern, without yielding traces of its former population. In the interest of the general investigation, I have therefore thought it might be useful to bring together the facts and speculations which are set forth in the preceding observations, as a guide to future inquiry.

XXVIII. ON THE GLACIER-EROSION THEORY OF LAKE-BASINS.

I.—ABSTRACT OF AN EXTEMPORE SPEECH DELIVERED BY DR. FALCONER AT THE ROYAL GEOGRAPHICAL SOCIETY, ON JANUARY 27, 1864, AND PUBLISHED BY THE SOCIETY.

DR. FALCONER, after describing the progress of the Trigonometrical Survey in India, next drew attention to the glacier system of the Himalayahs. All the best observers—Dr. Thomson, Jacquemont, and others—had been of opinion that there was but one great system of mountains. There was no such thing as any break of mountain range, or any distinct mountain chains. There were great rivers which cut them across, rivers like the Indus, the Sutlej, and some feeders of the Ganges; but, regarded in one grand aspect, they constituted a series or mass of mountains with ravines and valleys intervening. Viewed, then, in this light, there were two great ranges which culminated to especially great altitudes, and which bounded the Indus river to the south and the north; and this being one of the points where the Himalayan chain attained its greatest elevation, there the glacial phenomena were developed in most grandeur and upon the loftiest scale. Captain Godwin-Austen had referred to that part of the range which bounded the Valley of the Indus upon the north, the Kara-Korum or Mooztagh or the 'Icy range of mountains,' and the other great series of them were the mountains which bounded the Indus upon the south. Although the glaciers upon the Shiggur Valley and in the Valley of Braldoh, which he himself had visited in 1838,[1] were of such surpassing grandeur and importance as had been mentioned by Sir Roderick Murchison, it was but fair to other observers to say that upon the northern side there were glaciers which, so far as description went, were equally grand, if not grander. Those to which he should especially refer were the glaciers at the head of the Zanscar river, the sublime features of which had been so well described by Dr. Thomson. Mr. J. Arrowsmith, from his labours on the maps of Hugel, Thomson, and other explorers, was well acquainted with the mountain-ridge to which he referred, and the glaciers which arose from it. There was the river called the Chenab, and a mountain range which stretched across between the Indus and the Chenab. The pass of the dividing ridge at this point was 18,000 feet above the level of the sea; and upon either side, but more especially upon the north, at the heads of the Zanscar river, were some of the grandest glacier phenomena which were to be seen in any part of the world. There were glaciers extending from a very great distance, which attained

[1] See vol. i. p. 570.—[ED].

enormous width—confluent into a sea of ice—and which, until the description that had been given by Captain Godwin-Austen, had been unrivalled by any glacial phenomena with which they were acquainted, except the glacial formations in the Arctic regions, such as the Humboldt glacier in Smith's Sound, described by Dr. Kane.

With regard to the glaciers upon the north, the Indus ran through a long depressed valley westward, receiving from the north three great branches; the first branch, called Shayook, from the Kara-Korum, next the Nubra river, and also the Shiggur, which was the especial object of Captain Godwin-Austen's communication. Now, the Shiggur valley was the third of importance of all the affluents of the Indus, and was bounded by mountains of a great elevation. Some of them which had been measured by Major Montgomery attained a very great elevation; one a height of 28,000 feet above the level of the sea. This naturally entailed a prodigious amount of condensation of the moisture of the atmosphere, and led to a very heavy fall of snow, the result of which was seen in these glacial phenomena. Twenty-seven years ago he had been up to Arindoh, the extreme termination of the western or Basha branch, and from that point by a détour he got across upon the other valley by the Scora-là Pass to the glacier of the Braldoh river, where he saw all the phenomena which had been described by Captain Godwin-Austen.

Having premised this much with regard to special details, there were one or two points which he was desirous to bring before them. One was, What were the peculiar characteristics of the Himalayahs, as well as of all tropical mountains, as compared with our European mountain-chains? There was one characteristic of the Himalayan chain so remarkable that he should take the liberty of explaining it at some length. He presumed that most of his audience had visited either the northern or southern side of the Alps; and those who had been in the plains of Italy, along the Valley of the Po, were well acquainted with the numerous lakes which jutted out from the Alps into the plain of Italy. Commencing on the west, they had got the Lago d'Orta, the Lago Maggiore, the Lago Lugano, the Lago di Como, the Lago d'Iseo, and the Lago di Garda; in fact, wherever a great valley projected itself from the chain of the Alps at right angles to the strike of the chain, there they had, with one or two exceptions, uniformly a great lake. Regarding these lakes in a general way, without reference to detailed phenomena, they found one thing which was constant about them—'they were invariably narrow, and some forty or fifty miles long, as notably in the case of Maggiore, Como, and Garda.' The next remarkable thing about them was that they *invariably radiated out at right angles to the strike* of the great chain of the Alps. The Alps made a curve from the Pennine round to the Rhœtian Alps. They would also observe that these lakes were severally fed by a considerable river which proceeded from a high ridge of the chain, and which was thrown forward into the plains of the Valley of the Po.

If they would consider the Himalayahs, or any tropical range of mountains whatever, in a similar way, they would find that those lake phenomena were invariably wanting. Great rivers like the Indus, the Chenab, the Sutlej, and the Ganges, which passed through the Himalayan Mountains and debouched into the plains of India, had got valleys of

infinitely greater importance than the valleys either to the north or south of the Alps; but they were never connected with a lake.

The question then arose, What was the physical reason of this great difference between the tropical mountains and those of temperate Europe? Nearly thirty years ago, he was for ten or twelve years rambling about the Himalayahs along a stretch of 800 miles, and he used to open a map before him, and try to make out the comparative features of European and Eastern mountains. He looked to the numerous lakes to the north and south of the Alps; and he would put the map of India alongside, where the same kind of rivers were debouching into the plains, but where there was an utter absence of lakes in connection with them; and he used to puzzle himself in trying to discover a physical explanation of this difference. He was perfectly satisfied there must be some *secondary* conditions which were not common to the two, and he determined that, on his return to Europe, he should make them the subject of special research; for at that time the glacial investigations of Charpentier and Agassiz in the Alps were unknown to a solitary wanderer in the Himalayahs. That intention he had carried out, by repeated visits to the Italian valleys of the Alps. There was the same kind of elevation above the level of the sea, the same kind of valleys, the *same kind of fissures* intersecting the great ridges—What then was the explanation? This he would endeavour to indicate. About two years ago, March 5, 1862, as his friend Sir Roderick Murchison was aware, a paper was brought before the Geological Society of London by Professor Ramsay, which excited a great deal of attention, and gave rise to a very animated discussion. The theory of the paper was that, as a rule, lakes in all the temperate and cold regions of the world were the product of glacial excavation; that is to say, that wherever a glacier descended from a high ridge of mountains into a plain, it ploughed its way down into the solid rocks and carved out a great lake. This was the theory, or rather hypothesis which Professor Ramsay put forward, to explain the lakes which were so abundant in the valleys of the Alps. A similar speculation, but greatly more restricted, had been advanced by Mortillet a short time before. He limited the action of the glacier to scouring out the silt of the filled-up lake basins, the origin of which he attributed to *antecedent fissures the result of upheavement.* An application of this theory was made to the different physical phenomena which were connected with the case; and it occurred to himself and many others (and he believed Sir Roderick had an opinion in common with himself), that it was not adequate to explain the phenomena; and on the occasion when it was produced, he met it with the most lively opposition in connection with his own experience in the Himalayan Mountains. The opposition which he gave to it was upon these grounds. Many of them would remember that the lakes Maggiore and Como were upon the edge of the plains of Italy; that the glaciers, say that of the Ticino which came down into the Lago Maggiore, descended along a steep incline, and were at last delivered into that lake, which was about fifty miles long, and only eight or nine miles wide at its widest point. Its prolongation nearest to the Mediterranean attained a depth of about 2,600 feet below the level of the sea. Where the river escaped out of the lake it was not more than about 600 feet above the level of the sea. It was a

remarkable point in the case, that this glacier, by the hypothesis, should have ploughed its way down, and actually dived into the bowels of the earth 2,000 feet below the level of the Mediterranean, and then should have again risen up along an incline at a rate of about 180 feet per mile.

Without going into all the objections, he might state he believed the principal one was, that the mechanical difficulties in the case were entirely left out of sight by the supporters of that theory; and on that occasion, after very long study of the subject, he had endeavoured to bring forward what occurred to him as the true explanation of the difference between the Himalayan Mountains and the Alps. The difference he believed to consist in this: that after the last upheaval of the Alps, *great fissures, or basins of lakes*, were left there, with rivers running into them, in the manner in which the Rhone runs into the lake of Geneva, bringing down vast quantities of silt, which, if you give a sufficient number of ages, would have completely filled them up. But before this was accomplished, what is called the Glacial period set in; that is to say, there was an enormous projection of ice and snow, below the limit that they now saw it in the Alps, out into the plains, both to the north and south of that chain; and, as the snow and ice came down, they filled up those lakes, and formed a bridge, upon which the moraine material was carried over, there being a certain measure of incline from the summit of the Alps down to the plains of Italy When once the basins were filled with ice to the depth of 2,500 feet, they made, as it were, a slide or incline, upon which all the solid material could be transported; and that being carried forward by the *vis motrix* of the mass, formed the large moraine which we saw at Lake Maggiore, that of the Brianza, and also the moraine which bounded Lake Garda, where the battle of Solferino was fought. This was the *secondary* condition that occurred in Europe. Precisely the same *primary* conditions occurred in the great valleys of the Himalayahs, but without the same glacial phenomena. These mountains were thrown up above the level of the sea, *and vast perpendicular fissures* left, forming what constituted at that time the basins of lakes. But in those tropical regions, the ice never descended from the highest summits down into the plains of India; and instead of being filled up by snow, which afterwards melted into water, these lake basins were gradually silted up by enormous boulders and alluvium of every kind, which were transported down from the Himalayan Mountains in prodigious quantities by the torrential action of the periodical rains. The difference in the two cases was, that whereas the ice filled up the lake basins in the Alps, constituting, as it were, the conservative means by which those basins were saved from being silted up by alluvial and other matters, in the Himalayan Mountains this conservative action did not take place, and the lake basins remaining open got filled up in the manner above described. If they would look at the map of the Himalayahs, one of the most remarkable things they would observe on the southern side of the chain was, that there were no great lakes whatever—not one that would compare with Lake Lugano, or with any of the second or third-rate lakes in the Alps. But if they crossed to the northern side of the chain where the temperature was much colder during the winter, there they would find great lakes. The cold produced the same conservative

action on the northern side of the Himalayahs, in preventing the lakes being filled up, that it did in the Alps by restricting the silting action.

This was the main fact to call to the attention of the Society, with reference to the great difference between the Himalayan and other tropical ranges of mountains and those in Europe. The next point was one of some interest and importance. There was a material well known in commerce and arts, called borax, now largely employed in ceramic products. It used only to be got from India as an export from Tibet, and it was invariably found in connection with hot springs. Within the last twenty years a remarkable change had taken place. The late Count Lardarel, an original-minded and eminently philanthropic Frenchman, of Leghorn, aware of the presence of boracic acid in the jets of steam which are emitted from the surface of the broken soil in the ravines of Monte Cerboli, on the margin of the Maremma of the Volterra in Tuscany, hit upon the happy idea of utilizing the natural heat in lieu of fuel to effect the process of evaporation. Extemporized tanks fed by rills of cold water were employed to intercept the jets of steam, until the fluid got charged with boracic acid; while other jets of steam, tapped from the soil, were led off in pipes, and distributed under the evaporating pans. An unbounded supply of boracic acid was the result. As a consequence, the borax of Tibet fell in value from 37*l.* or 40*l.* a ton to nearly half that price, until at length borax was exported from England at the rate of 10*l.* per ton, to displace the native article from the bazaars of India. In Tibet the mineral occurs in the form of biborate of soda, that alkali in many places abounding in the soil; while in Italy it is yielded in the form of boracic acid. In both cases its appearance was coincident with a region of hot springs, which occurred at great elevations in the Himalayahs; and for the best account of their connection with borax he could refer to Dr. Thomson's 'Travels in Tibet.'

Connected with the Himalayahs, there was also a physical and vital phenomenon of still greater importance. Henry Colebrook, the first who, along with Colonel Crawford, measured the heights of the Dwalagiri, procured from the plateau of Chanthan in the Himalayahs, at a height of 17,000 feet above the sea-level, fossil bones, which were brought down and exported as charms into India, to which the natives attributed a supernatural origin, and called them 'lightning or thunder bones.' At the present time, during eight months of the year, the climate differed in no important respect from that of the Arctic circle, and in the whole of the district there was not a single tree or shrub that grew larger than a little willow about 9 inches high. The grasses which grew there were limited in number, and the fodder, in the shape of dicotyledonous plants, was equally scarce. Yet notwithstanding this scantiness of vegetation, large fossils were found, of the rhinoceros, the horse, the buffalo, the antelope, and of several carnivorous animals; the group of fossil fauna as a whole involving the condition that, at no very remote period of time, a plateau in the Himalayan Mountains, now at an elevation exceeding three miles above the level of the sea, where we get the climate of the Arctic regions, had then such a climate as enabled the rhinoceros and several sub-tropical forms to exist. It would occupy too much time to explain the details of this complex phenomenon. He would briefly state that the only rational solution

which science could suggest was that, within a comparatively modern period, a period closely trenching upon the time when man made his appearance upon the face of the earth, the Himalayahs had been thrown up by an increment closely approaching 8,000 or 10,000 feet.[1]

II.—Extracts from Letters by Dr. Falconer in the 'Reader' for February and March, 1864.

Terrestrial mechanical phenomena are susceptible of mathematical analysis on mechanical principles. A very eminent mathematician, and one of the most distinguished physical geologists of our time, Mr. Hopkins, has undertaken the mathematical investigation of the problem of mountain elevations, viz., 'to determine the nature of the effects produced by a general elevatory force acting at any assigned depth on extended portions of the superficial crust of the earth, and with sufficient intensity to produce in it dislocations and sensible elevations.' Suppose a given area, bounded by parallel lines, and indefinitely long as compared with the width, to be subjected to an expansive subterraneous force, acting simultaneously upon every point, and sufficient to bear up the superincumbent mass, the strata will at first rise in the form of an arch, limited by their extensibility, and at length give way to the strain. The resultant fractures will take place simultaneously in two directions; those of the first class, parallel to the line of greatest extension (the strike); the second, at right angles to the first, *i.e.* across the strike. Local and partial causes—such as 'irregularity in the intensity of the elevatory forces, and in the constitution of the masses on which they are supposed to act'—will cause the effects to deviate from strict geometrical laws.

Such, broadly and very imperfectly put, is the mechanical theory of Mr. Hopkins, which, so far as it has gone, has been regarded by mathematicians as a great step in the dynamics of geology, resembling that which affected astronomy when mathematical reasoning and calculation were directed to it 'at the turning point of its splendid career.' (Dr. Whewell, 'Anniversary Address,' G.S., 1838, p. 27.) Practically applied, it has been accepted by geologists as remarkably in unison with the phenomena of mineral veins in a definite known area; and the special application of it to the phenomena of the Weald and the Bas Boulonnais by Mr. Hopkins has been regarded as a very successful illustration of the truth of the theory. 'The remarkable breaks in the bounding chalk-ranges which give passage to the rivers flowing from the Wealden northward and southward are shown to correspond in situation with cross fractures, indicated by the theory, and sometimes rendered probable, and occasionally proved, by observation.' (Professor Phillips's 'Manual,' 1855, p. 598.) Mr. Hopkins has not yet given to the world the extension of the mechanical theory to the phenomena of great mountain-chains like the Himalayahs, where angular elevation, so to speak, is what we now see; but he distinctly admits: 1. That 'along the flanks of elevated ranges *longitudinal valleys* are not unfre-

[1] See vol. i. p. 177 to 185. The views above expressed led to an animated discussion in the 'Reader.' The extracts which follow are taken from Dr. Falconer's letters which appeared on that occasion.—[Ed.]

quently found running nearly parallel to the general axis of elevation.' 2. *Transverse valleys.*—'Deep valleys are sometimes found of which the directions are nearly at right angles to that of the general elevation.' He admits that these latter may frequently be due to the effects of erosion, but states that in some instances they appear to have been obviously formed by the elevation of the strata on either side of them; and he cites a beautiful example of this kind of formation in a river in Wales. So far as I am aware, no attempt has yet been made to investigate how much of the expansion of a transverse valley near the axis of a lofty chain like the Himalayah is due, theoretically, to a fissure of upheavement, and how much to subsequent erosion.

Suppose a given area of the bed of the ocean to be thus upheaved, so as to elevate part of it, in the shape of islands, above the sea-level, and leave part of it submerged, but with the dislocations and fractures and fissures of both orders within the scour of tides and currents: the abrading and solvent action of water, with other atmospheric agents, in the former case, and the movements of the ocean in the latter, operating during long periods, will produce enormous alterations of the exposed surfaces, denude, widen, and deepen the rents, fissures, and other inequalities. Let the action of ice be superinduced, as exemplified on the shores of Spitzbergen, Smith's Sound, and the ancient fiords of Norway, or upon mountain chains, the effects will then be produced on a scale of very great magnitude. But the fractures, fissures, foldings, and dislocations, and the uptilting of the beds caused by the original movements of upheavement have determined the direction in which the subsequent abrading and denuding causes have operated. The same line of reasoning applies to the upheavement into mountain chains of land already above the level of the sea. Something like the foregoing would embody the combined results of the mechanical theory and empirical reasoning.—*The Reader, Feb.* 27, 1864.

The Valley of the Jordan, regarded as a whole, is one of the most remarkable narrow rectilinear indentations of which physical geography has taken cognizance as occurring on the surface of the earth: a deep trench extending from the mouth of the Orontes at Antioch to the Gulf of Akabah, and bounded on either side by considerable elevations, but interrupted at two points—first, by Lebanon and Hermon, dividing the watershed of the Orontes from that of the Jordan; second, by the high ground bounding the basin of the Dead Sea to the south. The trough is thus divided into three segments, from north to south: 1st, in the Valley of the Orontes; 2nd, the Ghôr, or valley proper of the Jordan; 3rd, the Valley of Arabah. The second of these segments is that to which attention is now called. The Jordan arises out of springs near Hushbeyah, on the western flank of Mount Hermon, at an elevation of about 1,700 feet above the level of the Mediterranean. After receiving some affluents, it runs due south into the Lake of Merom (El Hûleh), a triangular basin about 4½ miles long by 3½ wide, and elevated about 50 feet above the level of the sea. The lake occupies the southern end of an intramontane plain 15 miles long by 5 wide, indicating the former boundaries of the sheet of water. From Lake Merom the river descends by a contracted channel to plunge into the Lake of Tiberias, with a fall of about 600 feet in a distance of 9 miles, being 66½ feet per mile.

That lake is 13 geographical miles long by 6 in width; its surface is 653 feet below that of the Mediterranean, and its greatest ascertained depth 165 feet, according to the cursory soundings made by the American expedition under Lieutenant Lynch. From the Lake of Tiberias the Jordan runs due south in a trough, as strait as an arrow, and about 7 miles wide from wall to wall, to plunge into the chasm of the Dead Sea —a distance of about 60 miles—during which it falls 983 feet, or at the rate of about 16·4 feet per mile. The immediate bed of the river, eroded by fluviatile action, is so excessively tortuous as, by calculation (Lynch), to triple the length of its course, which throughout is a nearly continued cataract.

The Dead Sea is 46 English miles long by 10½ wide, of a narrow oblong form, and its area has been estimated to cover about 250 square miles. The depression of its surface below the Mediterranean has been variously estimated from 1,446 feet (barometrical, von Wildenbruch) to 1,312 and 1,316 feet by trigonometrical and levelling operations, the former by Captain Symonds, the latter by Lieutenant Lynch. The last two estimates may practically be considered to be identical, as the height of the lake varies at different seasons, and Lieutenant Lynch's does not appear to have started from any bench-mark or fixed datum. Captain Symonds's estimate of 1,312 feet is adopted here.[1] The depth of the lake has been variously described. Messrs. Moore and Beeke assign a maximum of 2,400 feet; while Lieutenant Lynch, with a party of sailors accustomed to using the lead, only got a maximum, by soundings, of 1,308 feet between Ain Terâbeh and Wady Zūrka, about 9 miles from the mouth of the Jordan. This, added to Captain Symonds's result, would give a depression of 2,620 feet below the level of the Mediterranean. That this depth was originally very considerably greater can hardly be doubted, since the Dead Sea, with no outlet, has had poured into it the silt of the Jordan and of the other streams that flow into it, and have flown from all points of the compass during a long lapse of ages, of which there are no data for arriving at even an approximate estimate. The southern end of the lake has been filled up by the deposition of inpoured silt. That the chasm is precipitous is distinctly proved by Lynch's sections, he having ascertained a depth of 900 feet, close to the margin, on the eastern side. The southern extremity is bounded by the Khashm Usdum, or salt-

[1] Up to the time of his fatal illness, Dr. Falconer was engaged in collecting information on the physical geography and geology of the 'Dead Sea.' The last occasion on which he ventured out was to attend a meeting of the Council of the Royal Society, for the purpose of urging the propriety of voting a sum of money, for finally determining the vexed question of the relative levels of the Dead Sea and of the Mediterranean. This investigation was subsequently conducted by Col. Sir Henry James, and from a Report presented by him to the Royal Society on May 3, 1866, it appears that on March 12, 1865, the level of the Dead Sea was 1,292 feet below that of the Mediterranean, and it was ascertained that during the early summer the level of the sea falls at least six feet below the level at which it stood on the day the levelling was taken. The soundings in the Dead Sea by Lieut. Vignes of the French Navy gave a maximum depth of 1,148 feet, making the depression of the bottom of the Dead Sea 2,446 feet below the level of the Mediterranean. The soundings in the Mediterranean, midway between Malta and Candia, by Capt. Spratt, R.N., gave a depth of 13,020 feet, or a depression of the bottom five times greater than that of the bottom of the Dead Sea.—[Ed.]

ridge, on the south-west, and due south by a confused mass of unimportant low hillocks, composed of chalky indurated marl. From this point the trough rises along the Valley of Arabah to a point 35 miles north of Akabah, where it attains a height, in round numbers, of about 500 feet above the level of the western arm of the Red Sea, or 1,812 feet above that of the Salt Lake. For an excellent summary of the facts the reader may be referred to Mr. George Grove's article on the 'Salt Sea' ('Smith's Dictionary of the Bible,' vol. iii. p. 1173). The geological formation of the tract is nummulitic and jurassic, with dykes of basalt, which abound along the Lake of Tiberias.

The physical features of the tract have led almost all good authorities to infer—1. That a long straight fissure or crevasse, caused by mechanical disturbance, extended from Antioch to the Red Sea. 2. That a strait connecting the Mediterranean with the Gulf of Akabah was scoured out along this fissure forming the trough of the Jordan. 3. That the extremities of the trough were elevated, cutting them off from the two seas. 4. That the Jordan probably flowed at one time into the Gulf of Akabah. 5. That simultaneously with the upheaval of the Akabah ridge, the valley of the Jordan was depressed through a violent mechanical convulsion. 6. That, as a result of the last operation, the chasm constituting the precipitous deep basin of the Dead Sea was left. How was this chasm formed? That it was a volcanic crater is negatived by all the facts known on good authority; for details *vide* Dr. Anderson's Report and Russegger's Sections. Let us apply to the conditions the hypothesis so stoutly advocated, of glacier-erosion as the formative agent of lake-basins. The excavation to such a depth of a rocky area of 250 square miles, would involve an enormous terminal moraine, without reference to transported blocks and detritus, derived from the head and upper course of the glacier. Nothing corresponding has been observed by any explorer at the southern end of the Dead Sea. The salt-ridge of Khashm Usdum, the detached pillars of salt, and the unimportant eminences of chalky indurated marl, traversed by the Wady el Jeib, are not in accordance with the usual physical character of a moraine. To an argument so conclusive it may be needless to add others. But the lowest point to which Dr. Hooker traced the moraines of ancient glaciers on Lebanon was 6,172 feet above the sea. Could the ridges at the head of the Jordan have yielded a stream of ice which must have travelled 150 miles to reach the sultry chasm of the Dead Sea, and then scoop it out? How explain the string of the three lakes, El Hûleh, Tiberias, and the chasm of the Ghôr, with the sixty-mile trough between the two last? Erosion by marine or fluviatile action might account for the general excavation of the trough along the line of a fissure; but how can it be made to explain the sudden, irregular, precipitous chasm, so much below the general level, which is met with in the basin of the Salt Lake? That chasm occurs, at the point of greatest depression, where, to use a figurative expression, the back of the trough appears to have been broken during the convulsion which caused the subsidence. But, for the present argument, it is sufficient to indicate that the Valley of the Jordan presents along its course three well-marked lake-basins, the formation of which seems irreconcileable with the hypothesis of glacier-erosion.

I shall now revert to the lakes of Lombardy, which I had in view

while comparing the perpendicular or transverse valleys on the southern sides of the Alps and Himalayahs.

Take the Lago Maggiore, which is about 52 English miles long, and $3\frac{1}{2}$ to 4 miles wide, at the broadest part of the central portion between Luino and Laveno. It is fed by the Ticino, consisting of two main branches given off across the strike of the chain The basin forms a long, narrow, flexuous hollow, bounded by low hills, but open to the south. Its greatest depth, opposite Santa Caterina, at one of its contractions, about $12\frac{1}{2}$ miles from its southern extremity, is 2,605 feet, giving a general gradient of about 200 feet per mile for the rise of the bottom to the surface between the two points. Taking Lynch's estimate for the Dead Sea (1,308 feet), the extreme depth of the chasm occupied by water in the Lago Maggiore is double that of the former, and the depression of its bottom below the surface of the Mediterranean is 1,927 feet, being only about 678 feet less, or the height of the lake above the sea-level. It is even deeper than any soundings yielded in the Gulf of Genoa (*vide* Admiralty Chart).

The basin of the Lago di Lugano is so irregular in form, branched, and 'polype-like'—to use the phrase of Desor—that its erosion by a progressive glacier is not easily conceivable, but is readily so on the supposition of an intersection of fissures combined with aqueous erosion.

The Lago di Como is about forty miles long, and its body or northern half three miles wide; its surface above the sea-level is 695 feet; its greatest depth is 1,926 feet. Near the middle it divides into two long diverging arms (like the legs of a pithed frog), pointing southwards, and separated by the promontory of Bellaggio. The distance across between Lecco and Como, the extremities of the two branches, is no less than fifteen or sixteen miles. Upon the glacier-erosion hypothesis how is this great fork to be explained? If the glacier of the Adda Valley was adequate to the erosion of the profound lake, how did it spare the comparatively insignificant barrier of the promontory and separate into two diverging branches? If physical features are to be admitted as of any weight in the argument, it would seem as clear that the fissures existed before the descent of the glacier as if the eye of man had witnessed the fact.

The Lago di Garda, the largest of the Italian lakes, is about fifty-five miles long. Its form is irregularly gourd-like, the northern part or neck being three or four miles wide, and the southern or expanded portion fifteen miles, the whole covering an area of about 110 square miles: surface 227 feet above the Adriatic. Its depth is variously stated, as being 951 feet (É. de Beaumont), and 1,992 feet (Murray's Hand-Book). The latter would be most in accordance with the depths of the lakes Maggiore and Como, the Adriatic, as far south as Ancona, nowhere exceeding fifty-nine fathoms. The basin is bounded on the south by the enormous moraine stretching across between Lonato and Sommacampagna. Although now fed by the Sarca, and disconnected from the Adige, it was the great glacier of the latter valley which formerly contributed most to fill the basin of the Garda. A remarkable point in the physical geography of the case, and bearing on the argument, requires to be noticed. The Valley of the Adige, with the exception of the Pass of Calliano, is very open between Trent and Roveredo, and more especially open on its west side towards the Valley

of the Sarca. Below Mori it is crossed by a formidable barrier, composed of a lofty ridge, thrown off from Monte Balbo. This ridge is traversed by the narrow fissure and gorges of La Chiusa, bounded by mural cliffs like those of the defile of the Avon at Clifton, but greatly more contracted. The river Adige continues its straight course through the defile, to emerge above Volgarne and then pass on to Verona; but not a trace of an erratic block derived from the head of the valley, or of any other glacier indication, has been detected below the commencement of the defile. The ancient glacier of the Adige appears to have refused the gorge, and to have been deflected at right angles to its previous course, to pass westwards into the Valley of the Sarca, and thence into the chasm of the lake-basin of the Garda. The fact is strongly dwelt upon by Mortillet ('Ancient Italian Glaciers,' p. 25), and the *rationale* of the phenomenon is magnificently illustrated by the chaotic accumulation of the blocks and debris of the secondary moraine, called the Slovino di San Marco, a spot which struck Dante with awe, but which does not yet appear to have attracted the notice of English glacialists, who maintain the erosion-hypothesis of Alpine valleys and lake-basins.

It has been shown above, that an hypothesis of the Dead Sea having been eroded by glacier-action would be beset, to say the least, by very formidable difficulties. Excluding the facts that it occurs in an area of depression, and on a longitudinal instead of a transverse valley, there is much in common between it and the basins of the Italian lakes, viz.: extreme depth, great length compared with width, and chasm-shaped transverse section. Those who have faith in the order of nature will be strongly disposed to infer that the causes which operated on the production of the one have had a share in that of the others.

Each of the Italian lakes, taken apart, offers difficulties to the glacier-erosion hypothesis. The present Valley of the Adige, from its head down to Verona, shows not a trace of a lake-basin. That an enormous glacier formerly descended it, is beyond question; and equally so that that glacier must have greatly widened and deepened the channel along which it moved. But what is the dynamic *rationale* of the new function it acquired near the termination of its journey, of ploughing down into the bowels of the earth to a depth of nearly 2,000 feet, and in the case of Lago Maggiore 2,605 feet? Can such a result be mechanically sustained by mathematical calculation applied to the conditions of the problem? or does it accord with the observed effects of existing Alpine glaciers near their terminations?

I have already alluded to the difficulty in the case of the Lago di Como. Without pre-existing fissures to guide its course, by what means could a progressive glacier have split, so as to excavate, the diverging branches of Como and Lecco? Why was the promontory of Bellaggio left intact? In Lago Maggiore 12½ miles intervene between Santa Caterina, where the depth is 2,605 feet, and Santo Calande, where the glacier, emerging from the lake, was delivered on the plains of Lombardy, yielding, as already stated, a gradient of 200 feet per mile. Without reference to the fact that the bottom of the glacier, under the hypothesis in question, must have here performed the mechanical duties of an auger or a plough-share, could the *vis a tergo*, under the conditions of the problem, have propelled the bottom stratum of

ice up such an incline? Before admitting this, it would be desirable, in this case also, to see the practicability of the result established by mathematical calculation on mechanical principles.

Further, one of the greatest of the ancient Piedmontese glaciers, fed by the snows of Mont Blanc and Monte Rosa, descended the Val d'Aosta, to stretch far into the plain, and leave the enormous moraine of Ivrea, close upon the Po. The course of this glacier is marked by no great lake-basin, like those of lakes Maggiore and Como. If the latter were eroded by glaciers, how is the absence of a lake-basin in the case of the former to be explained? The same argument will apply to the important moraine of Rivoli near Turin, and to the smaller moraines between the Stura and the Dora Riparia, the whole of which are unaccompanied by rock-basin lakes. Superficial moraine-tarns are beside the question.

The expressions used by me did not differ materially from those employed by that eminent philosopher Sir John Herschel:—'In the upheaval of any extensive tract of land from the sea, hollows fitted for lake-basins cannot fail to be left. If the upheaval be rude and paroxysmal, resulting in the formation of mountain-chains, and accompanied with fracture and dislocation of the strata, such hollows will be deep, precipitous, and narrow, in proportion to their length. Such is the general character of lakes in mountainous regions—of the Swiss lakes for instance, of those of North Italy, &c.' (*Physical Geography*, 'Encyc. Brit.' vol. xvii. p. 591). Mortillet also, who maintains the questionable hypothesis that the lake-basins were first filled up by silt and then scoured out by the descent of the glaciers, expresses himself thus, in reference to the Italian lakes:—

'Le dernier soulèvement des Alpes, qui a eu une puissance énorme, a dû produire dans les fonds des vallées de grandes inégalités de sol, *de nombreux bassins*; en effet nous voyons ces vallées être une succession plus ou moins fréquente d'étranglements et d'élargissements,' &c. ('Anciens Glaciers Ital.' p. 17.)

My object on the occasion referred to was to endeavour to account for the remarkable difference between the Himalayahs and the Alps in the important physical feature of lake-basins, which are absent in the transverse valleys on the southern sides of the former, while they abound in the latter. With the exception of greater and lesser elevation, and magnitude of development, the two chains repeat each other in all their primary orographic conditions. It seemed clear that the difference must depend upon some secondary attribute, which might or might not be present in a mountain chain. The enormous frontal moraines which bound all the Italian lakes to the south made it certain that their basins had been in the track of glaciers of vast magnitude, and which had existed during long protracted periods. Conversely, lake-basins were wanting in corresponding situations in the Indian mountains, and glaciers, according to every aspect of the evidence, had never descended so low there. What then was the relation, in the positive and negative sense, of glaciers to the two cases? The supporters of the erosion-hypothesis maintain that the lake-basins were mechanically excavated in the solid rock by the grinding action of the glaciers in motion, working vertically.

The first objection to this view is that lake-basins are wanting imme-

diately behind the enormous moraine of Ivrea and behind that of Rivoli. If the cause was equal to produce the effect in the other instances, why did it wholly fail in these? The *onus probandi* rests with the advocates of erosion. The objections of the next class are still more formidable. Glaciers move and erode under the law of gravitation. Take the enormous Humboldt glacier of 'Peabody Bay' described by Dr. Kane. Between Capes Forbes and Agassiz it presents a front of cliff 300 feet high along a stretch of sixty miles, forming a stream of ice which is propelled uninterruptedly from the interior into the sea. 'The general configuration of its surface showed how it adapted itself to the inequalities of the basin-country beneath. There was every modification of hill and valley, just as upon land' (Kane, p. 358). The stream of ice in motion in this case exerts a *planing* action upon the rocks below by grinding, smoothing, and polishing. But there is no penetrating effect along contracted lines of excavation. The actual results of past conditions of the same nature are disclosed to us in Norway at the present day on surfaces which were in the track of ancient glaciers moving seawards. The area is ground, scooped, and polished, but the major inequalities remain.

The same conditions, under certain modifications, apply to glaciers descending from mountain-chains. Instead of spreading out horizontally, there they are pent up along contracted lines in Alpine valleys, accumulated in masses several thousand feet in thickness, and therefore exerting an enormous vertical pressure. The scouring, polishing, and eroding effect is thus proportionately augmented, but the nature of the action is not changed—it is still *planing*, not *penetrating*. Take the chasm at the bottom of the incline, as in the case of the Lago Maggiore, within a few feet of half a mile in depth. What new mechanical power did the ice acquire there at the end of its journey of excavating so profound an abyss? And, to repeat what I have already asked, could the bottom stratum of ice, under the enormous vertical pressure to which it was subjected, have moved up the incline in the given case? Observation on modern glaciers by the most experienced of all glacialists, the Swiss philosopher, has shown that a glacier at its terminus pushes the frontal moraine ahead of it, but that it exerts no peculiar excavating power at that point. So far as I am aware, not one of the Swiss geologists has come forward as a convert to the erosion-hypothesis. To a man, when they have spoken, they have pronounced against it.

The view which I advocated was, that, both in the Alps and in the Himalayahs, the lake-basins existed in the transverse valleys before the descent of the glaciers; that, in the former case, they filled the lake-basins, thus preventing them from being silted up, while in the latter, glaciers not having descended, the basins remained open, and thus were levelled by accumulated debris. Assuming that the basin-fissures existed before the glaciers, the explanation would account for the contrary phenomena in the two mountain-chains.—*The Reader, March* 5, 1864.

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THE END.

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